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ENTERED AT THE POST OFFICE AT NEW YORK, N. Y., AS SECOND CLASS MATTER.

[OFFICIAL CIRCULAR.]

American Gas Light Association.

AMERICAN GAS LIGHT ASSOCIATION, Oct. 10th, 1885.

As this is the last opportunity I will have of addressing the members before we assemble in Cincinnati, I am anxious to take advantage of the occasion to emphasize the appeal I have already made to each and every gentleman on our roll call that he make every effort to be present at our coming meeting, and that he come in the full determination to do all that lays in his power to make our Thirteenth Annual Convention a grand success. If the verdict which the chronicler of gas matters is to pass upon our Cincinnati gathering were to be entirely dependent upon those gentlemen who have kindly consented to contribute papers to be read at the meeting, we could hardly expect it to proclaim the success of the convention in the unhesitating manner it might adopt, other things being equal, if each member were to feel that the nature of that verdict were dependent in great measure upon himself. While, as I have spoken of this matter in previous circulars, I do not now wish to amplify my remarks in this direction, I do desire to urge the members to avail themselves of the time remaining before the meeting to collect such data and information as they can anent the subjects to be discussed, and present them at the proper time to the Convention.

The subjects to be discussed are indicated by the following list of promised papers:

"Natural Gas," by W. H. Denniston.

"Stoking Machines," by M. S. Greenough.

"Improved Furnaces," by Austin C. Wood.

"The Result of a Month's Working with Limed Coal," by James Somerville.

"The Thermophote, or Self-registering Photometer," by T. O'Conor Sloane.

"The Present State of the Gas Business," by J. C. Pratt.

"Difficulties Encountered in the Construction of a Gasholder Tank," by Emerson McMillin.

"Automatic Street Main Governors," by William Enfield.

Other papers have been promised, and will probably be prepared in time for the meeting.

I have also received, through the courtesy of a foreign correspondent, a condensed translation of a German paper descriptive of some of the European furnaces.

In addition to these subjects we have the following questions to answer:

"Is cannel or oil the cheaper enricher, taking $9 a ton as the cost of the former and 5 cents a gallon the price of the latter?"

"Can large gas burners successfully compete with the arc light?"

"How can the trouble from naphthaline be alleviated?"

"What is the proper position for gas exhausters?"

"Can the gas engine be successfully used to drive an exhauster?"

"What is the best means for removing tar from the gas?"

"Does a heavy setting of retorts require more coke to maintain the heat than a light setting?"

"What is the best and most expeditious mode of weighing coal, when discharged direct from vessel into store?"

"If, say, 4,000 tons of coal are stored for a year's supply, what is the average loss in weight when weighed again in retort house?"

"What is the relative illuminating power of coal gas, when tested simultaneously with the bar and jet photometer?"

"Why do burners, fed from the dead end of a gas main, stop up?"

"What is the most efficient, and easily cleaned, washer for removing lampblack from oil gas, and where should it be placed?"

"What methods are in use for stopping leaks in clay retorts, under pressure, say, 5 to 6 inches, other than simply charging with coal after patching?"

From the foregoing it will appear we have a rather ample literary programme for our meeting; it is, therefore, more than ordinarily necessary that the members be prompt in assembling at the appointed times.

The first two days of the meeting will be devoted to business. The details of the third day are not yet completed; but a visit to the new station of the Cincinnati Gas Company will be included in the arrangements. Programmes, which will be distributed during the meeting, will give full particulars of the details of the Convention.

As before announced, the headquarters of the Association will be at the Gibson House; and the meetings will be held at College Hall, opposite the Hotel. The convention will be called to order by the President on Wednesday morning, the 21st inst., at 10 o'clock, and will continue through the two following days.

It has been suggested to me that at our yearly gatherings many members on reaching the headquarters of the Association are desirous of knowing just who have arrived; but there is no means of obtaining information on this score save from the hotel register, which is often incomplete, as some of the members stop at other hotels than that selected by the Committee of Arrangements. To meet this difficulty I will have at the Committee's room a register book, and will be obliged if members, as soon as convenient after their arrival in Cincinnati, will kindly register their names in this book.

Special arrangements have been made for the transportation of members from New York city and Boston. Special rates have been obtained from the New York Central and Hudson River Railroad for delegates going to the convention from New York city. Orders for these special tickets can be obtained from C. E. Sanderson, Esq., 42 Pine street, New York city. One of these orders will enable the holder to obtain from the railroad noted above a ticket from New York to Cincinnati and return at the reduced figure. The return coupons will be good until the 30th inst. The tickets will *not* be received on the *limited* train. The train which most of the members from New York will take leaves the Grand Central Depot at 6 o'clock Monday evening, the 19th inst., arriving at Cincinnati at 6:30 the following evening.

Special rates between Boston and Cincinnati have been obtained from the Boston and Albany Railroad. Orders for these special excursion tickets can be obtained from the Secretary; the return coupons of these tickets will likewise be good to the 30th inst. The train which most of the Boston members will take leaves the Boston and Albany Depot at 3 P.M., Monday, October 19th. This train joins at Albany to the train leaving New York for Cincinnati at 6 o'clock the same evening. The two trains combine at Albany and form one train from there to Cincinnati.

Parties wishing to join the Association can obtain the proper blanks by applying to the Secretary.

C. J. R. Humphreys, Secretary,
Box 6, Lawrence, Mass.

DO YOUR DUTY.

It may be taken for granted that close scrutiny has been given to Secretary Humphreys' final note of warning in regard to the Cincinnati meeting, and it is also presumably certain that the members of the American Gas Light Association have resolved to perform their entire duty in connection with the approaching convention. This year the excuse cannot be advanced that the topics for discussion were not announced in time sufficient to afford ample scope for study of their salient features.

Besides the presentation of specially prepared papers on stated subjects, Secretary Humphrey's circular enumerates a list of questions to be proposed and answered during the sessions. To the end that the replies may have real value we would urge the importance of searching through your records in the endeavor to fortify your opinions by the presentation of unimpeachable facts and figures. Do your entire duty, then, and grumble not at the slight labor involved in making the investigation, since, if all come fitly prepared, each member is certain to be amply repaid in the enlightenment gained by him from listening to a recital of the researches of others.

OBITUARY NOTE.—DR. E. B. WOODRUFF.

It is with sincere sorrow that we find ourselves placed under the necessity of announcing to the fraternity the demise of Dr. E. B. Woodruff, President of the Morristown (N. J.) Gas Light Company, who answered the summons of the grim reaper at midnight of Sunday, October 4. The deceased was born in Mendham, Morris County, N. J., on the 22d day of November, 1814, and arriving at that period of his youth when it became necessary to make choice of the avocation or profession that should be followed in maturer years, he decided to fit himself for the duties and obligations attaching to the life of a physician. Accordingly he entered the College of Physicians and Surgeons, then a celebrated academy of New York city, and in due course of time emerged therefrom eager to accept the responsibilities of his new sphere in life. Our young graduate returned to his native township and speedily established an excellent practice, gaining a reputation in his profession second to none other then enjoyed by his brother practitioners of that day and locality. About the year 1845 Dr. Woodruff removed to Morristown (Mendham is about 7 miles west of Morristown), and in that beautiful and historic place passed the remaining years of a truly happy life. Shortly before becoming a resident of the latter town the Doctor had resigned from the ranks of practicing physicians on account of certain commercial ventures which demanded the full measure of his attention in order that the same might be carried to the point of complete success. At beginning of year 1855 many of the residents of Morristown considered that the appearance of the local field presented sufficient encouragement for the establishment of a gas company, and the subject of this obituary note was prominent in the ranks of the agitators of the project; indeed, we might venture the assertion that years might have elapsed before the scheme was carried out were it not for Dr. Woodruff's persistence in the matter. Be that as it may, the "Morristown Gas Light Company" was chartered on February 19, 1855, with Dr. Woodruff as one of the charter members; and it goes without saying that the new venture had the full benefit of his advice, together with the advantage of his substantial pecuniary assistance. In 1876 deceased was elected to the Presidency of the corporation, which office he occupied uninterruptedly up to the time of his demise. He was also a charter member, and lately had been elected to the Presidency of, the Board of Trustees of the Evergreen Cemetery Association—Morristown's local burying ground. Deceased was a prominent member and regular attendant at the services of the congregation worshipping in the structure known as the South Street Presbyterian Church. A daughter and three sons survive him, one of the latter (Francis E.) enjoying the distinction of being one of the members of the commission of three Americans selected by the Chinese Government and employed by that Power in its Custom House at Canton. The funeral services were celebrated at the former residence of deceased on afternoon of Thursday, October 8, and it needed but a glance at the assembly to reveal what niche was occupied by the lamented dead in the hearts of his associates and fellow-townsmen. Dr. Woodruff had been a resident of Morristown for upward of 40 years; and that surely should afford ample time wherein to find him out. To his memory let it be said he was found out, in that everyone who knew him was his friend. While essentially a domestic man, in so far as he loved the quiet comforts of the home circle, he was in no sense a recluse, as his active participation in local matters shows. No smile was more affable nor greeting more kindly than his; and although he lived to the allotted age of three score and ten his demise will be none the less keenly felt.

Report of Transactions, 1885 Meeting of The Gas Institute.

We cannot forbear making mention of the commendable despatch displayed by Mr. W. H. Bennett, Secretary of the English Gas Institute, in editing and causing to be published in such short order the "Transactions of the Gas Institute for 1885," a copy of which has been received by us. The volume comprises an official record of the doings of the Institute, including therein the report of the council; an obituary note on the late M. Servier, former editor of the *Journal des Usines a Gaz*; President Newbigging's annual address—which was properly characterized by our English correspondent, in his letter of July 10th (see JOURNAL, Aug. 3, p. 66), as a "masterpiece of presidential addresses, both in respect to the soundness of its facts and the elegance of its composition;" the several papers read (with the discussions thereon) accompanied by handsome illustrations, and valuable statistical tables; the volume terminating in a mass of interesting matter relating to the Institute, such as membership lists, rules, etc. Owing to pressure on our columns we have this year been unable to adhere closely to our usual practice of reprinting the papers read at the Institute meetings, and in view of that fact any of our subscribers desirous of obtaining a copy of the "Transactions" may order the same through us, enclosing the sum of $4.40 in payment therefor.

In noticing the "Transactions" it would hardly be fair to omit mentioning that the get up and typography of the work have received full justice at the hands of the printers, Messrs. King & Sell, Fleet street, London.

The Market for Gas Securities.

Consolidated gas (after advancing to 98¼ since time of last writing) has had a set back in value, which decrease is accounted for by some on the ground of sales by insiders. The lowest figure recorded during the fortnight was 95¼, though bulk of transfers were made between 96 and 97½. Other city shares show an advance. Mutual Company has declared and paid a regular quarterly dividend of 2½ per cent. Brooklyn shares are fairly steady. We note that Fulton Municipal Company to-day pays a quarterly dividend of 3 per cent. The state of market may be characterized as sluggish.

Some Notes on the "Novelties" Exhibition Now Being Held at Philadelphia, Under the Auspices of the Franklin Institute of Pennsylvania. (Article No. II.)

By H. C. Adams.

The Lowe Gas Processes.

The production of illuminating gas from coal by destructive distillation had scarcely been demonstrated to be a commercial possibility before experiments were begun with a view of supplanting that process by a cheaper and better one. Although that experimentation has continued uninterruptedly for nearly three-quarters of a century, there has never been brought forth a system that has shown itself, after practical and sufficient test, to be superior to the coal gas process. Some of these patent methods and appliances have produced a richer gas, others a cheaper gas, and there have been many improvements; but when all the requirements essential for the best production, distribution, and consumption of gas, with regard to the interests of both producer and consumer, have been considered, these newer processes have been found wanting. Many of them have enjoyed a short, meteoric career of splendor, but have sooner or later sunk into obscurity and disuse. Such is the teaching of the history of gas making.

Nearly all of these promised successors of coal gas have had oil in one form or another as their principal factor. The richness of a direct oil gas necessitated its mixture with air or other diluting gas, and finally resource has been had to what is called water gas as the most practical diluent. The principal difference, and very nearly the only one, between the most prominent water gas processes of to-day lies in the method of delivering the oil to the gasifying chamber; and hence, when we have described one system we shall, neglecting a few minor details, have described the theory and practice of all.

At the "Novelties" Exhibition the Lowe Manufacturing Company, of Norristown, Pa., display the inventions of Mr. T. S. C. Lowe. Prominent among those is a complete fuel gas plant, which will now have our attention. At the northeastern corner of the Exhibition building, in the end of what is called the boiler house, we find the Lowe apparatus. The essentials of a water gas plant are (1) a generator and (2) a superheater. Originally those two pieces were separated in the Lowe system, but lately they have been combined into a single piece of apparatus, which, as shown at the Exhibition, is a cylindrical sheet-iron stack, 20 ft. high and 4 ft. in diameter, lined with firebrick. About 18 inches above the bottom of this stack is a water grate, with an ashpit below it, into which opens a door to permit of removal of the ashes, etc. Half way up the stack is a charging hole, worked from an elevated platform to which the coal is hoisted. The portion of the stack between the charging door and the grate is called the generator. Just above the charging door there extends across the stack a brick arch perforated with vertical flues, to make communication with the generator. Above the arch firebricks, set with interstices between them, are placed. This portion of the stack, from the arch upward, is called the superheater. At the top of the superheater a valve, opening to the outer air, is set in the cap of the stack.

In order to proceed with gas making a fire is built in the generator, which is filled from the charging door with an 8-foot bed of egg-size Lehigh or other good, hard, anthracite coal. Then the ashpit and charging doors are closed, and, the valve at the top of the stack being open, an air-blast is applied at the bottom of the grate. The bed of coal is thus brought up to a cherry-red incandescence, which process is known as "blowing up." The resultant gases, of which the principal is carbonic oxide, are met as they pass up from the coal by another air-blast, injected just below the superheater arch, and called the superheater blast, and are burned off, making, of course, an intense heat which raises to a bright-red heat the mass of firebrick in the superheater, through which the burning gases ascend. The products of combustion pass out by the valve at the top of the stack. When the coal reaches the proper degree of incandescence, and a proper heat appears in the superheater, the blast is shut off, the valve at the cap of the stack closed, and the process of gas making proper is begun. Steam is now injected through a ¾-inch pipe at the top of the superheater; it passes down through the glowing mass of brick, and is highly superheated; then it descends through the bed of incandescent coal, where it is broken up—the hydrogen being liberated and the oxygen uniting with the carbon to form, first, carbonic acid, and finally carbonic oxide, owing to the absorption of another atom of oxygen by the carbon of the coal. The resultant is a pure water gas, composed of hydrogen and carbonic oxide in about equal proportions. This passes off through an outlet below the grate of the generator, and travels a few feet to another sheet iron cylindrical stack, 4 ft. in diameter and 12 ft. high, which constitutes the washing and scrubbing apparatus. The lower section of this stack is the washer, which is simply a tank of water 3 or 4 ft. deep, into which the gas seals after the manner of delivery into a hydraulic main. At the top of the washer, just below the surface of the water, is a sheet iron diaphragm, around the sides of which the gas makes its way to the scrubbing chamber above, filled with coke through which a fine stream of water percolates in the orthodox manner. Then the gas is passed to the purifier, which is here a box 4 by 6 ft., with a 30-inch seal, filled with iron sponge; this is supplemented by an adjacent tank of milk of lime. The holder stands just without the boiler house; it has a capacity of about 5,500 feet, and seals into an enormous cedar tank containing about 180 tons of water.

The capacity of this plant is estimated at 5,000 feet an hour; at present it is making about 20,000 feet per diem. The heats we have described last about 15 minutes, reckoning from the time the blast is shut off and the steam put on. They claim to get 3,000 to 4,000 feet "to the heat."

So far we have spoken only of pure water gas, or fuel gas, as it is called by the Lowe Co. At the Exhibition a portion of this gas, after leaving the holder, is passed through a system of carburetters, consisting of galvanized iron boxes containing a suitable light oil; the gas in traversing these boxes takes up a portion of the oil, and is then burnt like ordinary gas in various kinds of burners. This carburetting is not a specific exhibit, but is done to show the relation of fuel gas to illuminating gas.

The Lowe carburetted gas, as made ordinarily in the works now using that process, is produced with a slight change from the working we have described for fuel gas. Instead of steam being injected at the top of the superheater, it is let in below the grate of the generator, and in passing up through the coal its elements become dissociated and arise from the top of the bed as hydrogen and carbonic oxide. Just below the superheater arch a piece of ordinary gas pipe is passed into the stack through a stuffing-box, to permit of its withdrawal when the fire is being blown up. Through this pipe oil, preferably naphtha, is allowed to flow to the interior of the stack in quantities varying from a trickling dribble to a full stream, according to the results desired, and depending on the candle power and quantity of the gas to be made. No force other than a slight gravity pressure is used to drive the oil into the stack. As soon as the oil enters it is volatilized, and the vapors are picked up by the water gas rising from the coal. These then pass up into the superheater, where they are converted into a fixed gas; and from the top of the superheater they are delivered to the washer, scrubber, and purifiers. The worth and efficiency of the process are, of course, to be determined by its comparative economy, which is so entirely dependent on circumstances as to make it impossible to give an exact statement. Its chief factors are the cost of oil, coal, and labor. It is claimed theoretically that 1,000 feet of 20-candle gas can be made from 40 pounds of coal and 4 gallons of oil; and that 100,000 feet of gas per man per day can be made in large works! We do not believe that those results are approached even under the most favorable conditions in actual practice. In our limited experience we have met many instances where practice fell sadly behind such figures; and we have never met one instance of their complete fulfillment. The question of the suitableness of this gas for domestic consumption has been so thoroughly discussed in the Journal that it needs no mention here.

The Lowe Incandescent Gas Light.

Nearly all investigators in the field of illumination, whether by gas or by electricity, have sought for a substance that, while admitting of practical manipulation, would suffer incandescence in air without resulting consumption. The greatest activity in this research has been, of course, displayed by the electricians, for its success most intimately concerns their lighting systems of to-day. So far have they been from solving the problem that it has been well-nigh given up, and the direction of the work changed toward obtaining a substance that will go only so far as not to disintegrate under continued incandescence in vacuo. The status of the duration and efficiency of the best incandescent lamps to-day show how far the second attempt has succeeded.

With these few prefatory remarks we can appreciate the worth of a discovery of a practicably indestructible vehicle for incandescence in air, and one that combines with indestructibility the other qualities essential for the emission of a light that may be utilized economically. That, and no less than that, Mr. Lowe claims to have accomplished in his incandescent burner. Careful investigation of such a claim is necessary before it can receive acceptance. The data essential for an opinion is so hedged in with mystery that we can give only the results of superficial observation. The burner is, as has been recently stated in the Journal, simplicity itself. It is but a spiral of wire, in the form of a horseshoe, set over the tip of an ordinary gas burner. The spiral, which forms a half circle, is supported by a backbone wire whose extremities attach to a horizontal base consisting of a strip of sheet brass, with an opening at its center, to give it a seat on the burner tip just below its top. The tip is fed with Lowe fuel gas, which, as has been shown, consists of gases of little or no illuminating power, but of great calorific intensity. The spiral of wire is arranged in the plane of the slot of the burner and of the sheet of gas issuing therefrom. When the burner key is turned and the fuel gas ignited, it strikes the spiral as it ascends, and brings it in a moment to an incandescence that quickly reaches its normal intensity. In the burners at the Exhibition the diameter of the half circle which the spiral describes is about 1¼ in., and hence the luminous arc is about 2 in. in length, the width of some being about ¼ in. The tip used with these is a nominal 2-ft. one, burning in practice 4 or 5 ft. That

size, it is claimed, gives a light of 15 candles! The length of the spiral depends, of course, on the size of the tip used; for the radius of the half circle which it describes must always be of such length as to bring the wire in the line of most intense combustion in the flame. In viewing the mechanical construction of the burner we are at once struck with the fact that, in order to have proper and full incandescence, the spiral must sit *exactly* in the plane of the slot of the burner and of the flame issuing therefrom. Should the wire not be properly adjusted when placing it on the tip, or should it subsequently be warped out of position by the action of the heat, or other means, the full efficiency is at once lost. It is very rarely that any of the 12-burner incandescent clusters at the Exhibition can be inspected, when in action, without finding 2 to 6 of the spirals partially dead; and the single spirals on the brackets and chandeliers in the rooms are frequently discovered to be only half in action. Apparently they need constant attention so that they may be kept at their normal efficiency. Again, should a slight, but steady, draught, sufficient to divert the flame from a direct vertical path, blow upon the burner, the incandescence falls to a dull glow kept alive by the indirect action of the adjacent flame. We should state, by-the-way, that all the incandescent spirals at the Exhibition are naked—*i. e.*, not enclosed by any description of globe. It was desired to give a cut of the burner in connection with this description; but Mr. Lowe, with proper and pardonable jealousy of so great an invention, does not allow any of the burners to pass out of his possession. Great curiosity and interest center in the composition of the metal composing these spirals. It is commonly supposed to be some alloy of platinum, and that is probably pretty close to the truth. As yet no careful and scientific tests have been made, so far as we know, to determine how far the metal does approach indestructibility. All the evidence gleaned in that direction lies in the statement made by the Lowe Company, that some of the spirals have been in use, off and on, say as we would use an ordinary jet, since last January; that others have had an actual average use of 2½ hours per night for three months; and that none of those showed appreciable deterioration. Of course, nothing definite can be said, yea or nay, on the question until the metal has been submitted to systematic and scientific test. The theoretical 15-candle spiral is to be sold at a price of $1. With an indestructible burner at $1, and fuel gas at 50 cents, such a stupendous economy is discovered as almost to betray its origin. The quantity and the tone of the light emitted are all important considerations. And here, having had our expectations wrought up to the point of "a new rival of the electric light," we experience rather a painful mental tumble; and when we alight with a bump upon the ground of hard facts, we begin to wonder what all this talk has been about. It is, of course, almost impossible to say, from observation by the eye alone, what the actual candle power of these spirals may be. One is much impressed by the apparently small quantity of light emitted from a single spiral. It would seem that with the present intensity a much larger radiating surface is needed. When the lights are burning in clusters and re-enforcing each other, that is not so evident; but when a single spiral is seen in one of the rooms the paucity of its light is very striking. The incandescence seems far too low; and if we may perpetrate an execrable pun, we will say that it is so.

In appearance the light affords a small luminous arc, of the dimensions given above, ornamented by small radiating horns of fuel gas, resulting at times in a rather weird effect. In tone the light emitted is of a dull reddish yellow. That effect is much intensified by contrast, for Mr. Lowe has unfortunately placed his lights alongside of the Siemens and Lungren lamps. The comparison is almost too much for the red-hot poker glow of the incandescent gas light.

Whether a higher intensity of incandescence is compatible with indestructibility we cannot say. The emission of a clearer, whiter light in such incandescent gas lights as the Fahnehjelm, where the magnesia comb is used with splendid effect, is had at the cost of comparatively rapid consumption. We do not see that with his present light Mr. Lowe has made a notable advance over the many other appliances which have been designed to utilize the intense combustion of water gas for lighting purposes. We observe that in his system at the Exhibition each spiral is removed, carefully cleaned, and readjusted or replaced daily; and that the operation of "lighting up" consumes about two hours each afternoon. If no more and no better light can be produced from a given amount of apparatus than is obtained at the Exhibition, the incandescent light will not approach, much less surpass the quality and economy of the effect derived from our ordinary illuminating gas. A poor light is not desirable even if it be ever so cheap; and with every desire here, as always, to "give the devil his due," we are constrained to say that the Lowe incandescent light at the Exhibition is poor. To those who looked for a new and brilliant departure in gas lighting, it is a most intense disappointment.

The Lowe Manufacturing Company's General Exhibit.

The Lowe Manufacturing Company make a very extensive and noticeable display. In the eastern end of the Exhibition building they occupy the rooms that were last year enclosed for the Brush Electric Company. The first of these is a parlor illuminated by one 12-light chandelier and two single brackets on the incandescent plan; next in line is a dining-room, and last comes an office opening upon the eastern aisle. All of these rooms are handsomely fitted up, and all contain the incandescent light. In the parlor is an open fireplace, where a series of fuel gas jets play upon a back of some refractory, asbestos-like substance, giving a glow of striking resemblance to the adjacent lights. Two devices shown in the office deserve mention—one is a method of conducting the products of combustion from a cluster light burning in a room on one floor, up to a heater or radiator in a room above; the other is the burning of a cluster light on a pedestal surrounded by a globe inclosing the light, the products of combustion from which are carried down by a central flue to the base of the pedestal, which is constructed as a heater; and after circulating through that are taken to some convenient outlet. The fuel gas is also used in the ranges of the restaurant at the Exhibition, and also in some baker's ovens in the main hall. To the north of the series of rooms just mentioned is an exhibit of the Lowe ranges, stoves, etc. These are similar to the ordinary make, save that the gas is delivered direct to the pipes, and no Bunsen burners are used. In fine, the Lowe exhibit shows creditable and praiseworthy enterprise, that might be profitably imitated by other manufacturers of gas apparatus.

The Kendrick Incandescent Gas Lamp.

The Kendrick incandescent gas lamp, the invention of Mr. I. Kendrick, of Philadelphia, is exhibited in the booth of the Pennsylvania Globe Gas Light Company. This lamp is of unique construction, and embodies a peculiar principle. The gas from the delivery pipe of an ordinary bracket, upon which the lamp can be readily placed, enters a small cylindrical chamber at the bottom of the lamp. From that three branch pipes diverge at equal distances apart, and ascend vertically to an annular chamber, like the gas chamber described in the Wassermann lamp, upon which the lip—a circle of orifices—is directly set. From the top of the cylindrical chamber into which the gas first enters is a vent into a vertical pipe that ascends through the center of the lamp to a point about an inch below the main tip; near the bottom of this central pipe is a series of orifices to admit air, and at its top is a suitable tip to give the effect of the Bunsen burner. Extending up from this tip is a cylinder of porcelain, which reaches to the height to which the illuminating flame from the outer burner is supposed to play—some 2½ inches. The upper half of the lamp is surrounded by a cylindrical clear glass chimney, from whose upper edge, hanging by a suitable lip, there extends down to the top of the flame a concentric, cylindrical piece of porcelain. This gives a closed annular space above the flame, which is supposed to act as a cushion and regulate, or rather steady, the action. Within this annular space is an outlet direct to the air.

Around the outside of the annular gas chamber, and extending up to the top of the burner orifices, is a draught collar of sheet brass, designed, by means of an inward curve at its top, to deflect upon the flame the air ascending through the outer portion of the body of the lamp. The whole of the lower part of the lamp is encased in a jacket, perforated at the bottom to give outlet to the air.

The operation of the lamp can be readily understood. When the supply cock is opened the gas enters the cylindrical chamber at the bottom of the lamp, and part of it ascends through the three branch pipes to the gas chamber, and thence to the tip of the main or primary burner, where it is ignited and burns with a flame shaped like the ordinary Argand. The rest of the gas ascends the central pipe, mixing with air as it does so, and upon issuing from the Bunsen burner it is ignited by the heat of the flame of the primary burner. We should have stated above that the lower portion of the porcelain cylinder set upon the Bunsen, or secondary cylinder, is cone-shaped, so as to deflect the products of combustion outward upon the main flame. The object of the secondary burner in the center of the lamp is to create a draught of air up through the central passage, and to heat it before it reaches the inner side of the flame, which it is supposed to feed. There is no attempt to pre-heat the gas, save to a slight degree where it enters the gas chamber surrounding the secondary burner.

The flame of the main burner burns up around the central porcelain cylinder, and gives a band of light, in the 10-foot lamp, about 2½ inches high. The light is clear and steady, but it does not seem much whiter than an ordinary gas jet would be with a porcelain backing. However, the burner at the Exhibition is using machine gas, which makes it difficult to gauge. It is claimed that when working with proper efficiency it gives 8 candles to the foot. The lamp has just issued from the workshop, and has not yet been put upon the market. At present three sizes are made—5, 10, and 15 feet; but as soon as the lamp is brought out it is proposed to extend that list considerably. As has been shown, and as its name sets forth, this lamp is not regenerative in principle, but apparently depends upon the incandescence of the central cylinder to intensify the light. We believe that any lamp that uses an extra amount of gas to supply a secondary or auxiliary burner to pre-heat the air supply, and at the same time allows a current of highly

heated products of combustion to pass off unutilized from the chimney, is false in theory; but then, as we learn every day, theory and practice do not always bear each other out. The truth of the case here can, of course, be demonstrated only by experience. The Kendrick lamp, although exhibited by the Pennsylvania Globe Gas Light Company, is the property of the Incandescent Gas Lamp Company, of Philadelphia.

The Effects of Heating Air upon Combustion.

By William Gadd, C.E., of Manchester.

[A paper read before the 1885 meeting of the British Gas Institute. Reprinted from the *Journal of Gas Lighting.*]

I think I may safely assume that most of the professional gentlemen here present are somewhat familiar with the series of articles which I had the honor to contribute to the *Journal of Gas Lighting* some little time ago, upon the subject of heating air in regenerator furnaces. These articles were the outcome of an investigation into the subject, which was first suggested to me by your learned President, in consequence of the controversy started by Mr. Valon at your last meeting; and I may here state that but for that controversy it is highly improbable that I should have been before you today for the purpose I have in view.

I may say that the investigations I made, for the articles alluded to, caused me to doubt certain conclusions which seemed to have become accepted without demur; and, as a consequence, I have been working at the subject of heated air practically from that time to the present.

In the furnaces and burners of modern times it has been the object to heat the air used for combustion to the highest point possible, by means of the waste gases, as it has been desired to return as much of the waste heat from the products of combustion back to the furnace as is practicable. How much or how little of this is accomplished I do not now intend to consider; but I desire to point out the somewhat obvious fact that, whether we return a given portion of this heat by means of air to the furnace, or whether we prevent to the same extent its escape, in the first instance, by way of the chimney, the real effect is simply to conserve the heat for useful purposes instead of allowing it to radiate into the open air or surrounding objects. It is well to bear in mind this somewhat axiomatic truth in the consideration of what I shall now have the honor of putting before you.

It has, I think, been generally accepted that heated air brought to a furnace or burner causes the temperature of the flame therein to rise, not only on account of the augmentation of temperature of the same by the heat brought forward in the air, but also that this heated air, by raising the temperature of the flame, directly intensifies combustion. This belief is largely exemplified by the numerous regenerative lamps and furnaces which so carefully make provision for the heating of air. I am quite aware that some investigators have, in the case of lamps at least, expressed the suspicion that *some* of the effect produced is due to the heating of the gas; nevertheless, this seems at best to have been thought to occupy only a secondary place of usefulness.

I may say that for a considerable period, on purely theoretical grounds, I have strongly doubted the value of heated air, at ordinary pressure, as a means of intensifying, or causing more perfect combustion; and the investigation already referred to strengthened these doubts to an enormous extent. An observation made by Mr. H. B. Dixon, in connection with some experiments on a certain regenerator burner, in which he found that a small quantity of cold air let in at the bottom or lower part of the lamp much increased the intensity, produced a strong impression upon my mind, and confirmed the views I had formed. I therefore resolved to devise some simple experiment which would determine the point.

Many methods were tried, all of which showed in some degree the expected result, and strengthened the belief in the discovery which theory pointed out; but I desired to formulate some method which should make the conclusions unmistakable and plain. This, at last, I was able to do, by finding a peculiar phenomenon of flame, which I term "a balanced flame of imperfect combustion." In this I recognized the means for what I conceive to be complete demonstration of that which I had long suspected—namely, that, so far from the heating of air in passages, at constant or ordinary pressure, increasing combustion, it actually retards or renders combustion more imperfect. I will try and show why this is so, and will, by the aid of the diagram, describe the simple experiment which demonstrates it, and afterward repeat the experiment to such as may be able to see it, as this may be difficult, on account of the smallness of the apparatus employed; while all may, with ease, construct their own apparatus, and repeat the experiment at leisure, on any scale they may prefer.

First, I will point out that combustion, termed a chemical operation, is really a mechanical phenomenon of a certain order, wherein—in the case, say, of combustion of carbon—we have two molecules of oxygen combining with one of the fuel. Now, it is clear that if we have, in any volume of carbon, x number of molecules, we require $2x$ number of molecules in the volume of oxygen, or, in chemical phrase, two volumes of oxygen, to form perfect combinations, or, in other words, perfect combustion. Thus, if our arrangements only allow x number of molecules, or one volume, of oxygen, we have resulting an imperfect combination or combustion in the form of carbon monoxide. Although, in practice, the imperfection of combustion is not necessarily uniform, as one portion may result in carbon-dioxide, another in carbon-monoxide, and a third as escaping carbon.

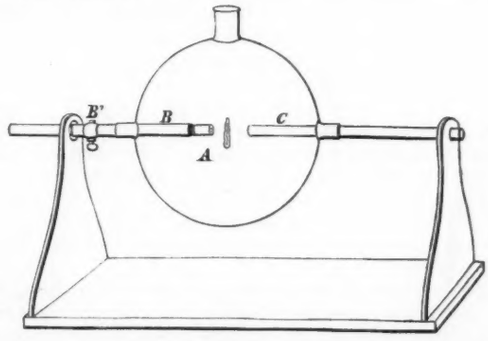
The application of heat to the gases expands them; expansion meaning, not an increase in the size of the atoms forming the molecules, but an increasing of their distances apart from one another. Hence when air, or any other gas, is expanded, there is a less number of molecules in a given measurement. It therefore follows that with a given size of air passage to an inclosed furnace or flame, at a constant pressure, a more perfect possibility of combustion results from the admission of cool air than when the same is heated, as cool air contains, in each cubic measurement, a far larger number of molecules of oxygen than is the case when in a heated condition at the same pressure; in other words, is denser, as is well understood.

The amount of heat evolved, at a given intensity, from a given quantity of carbon, entirely depends upon how many of the molecules of carbon obtain their requisite two of oxygen; and when every molecule obtains its desires, perfect combustion ensues, all the possible molecules of the compounds have been formed, and that fills the measure of heat capable of being evolved.

The air passages of a regenerator furnace or lamp will give one of three results: Either they will supply an insufficient amount of air at a given pressure and temperature; or they will supply the exact amount; or they will introduce an excesss of air over and above that which is required for the production of perfect combination or combustion.

If we take the cases of either an exact amount, or a not quite sufficient amount, or even slightly over the amount required to produce perfect combustion, when supplied at ordinary temperature and constant pressure, any heating of the same, prior to contact with the fuel, has exactly the same result as that of reduction of pressure at constant temperature, and at once renders the combustion less perfect. I am aware it is often assumed that the force of expansion produces increased speed in the passages; but this is not so, as the force of expansion takes effect equally in every direction. Therefore the pressure forward, due to expansion in the passage, is balanced by the pressure backward, due to the same cause; with the result that the volume of air travels forward at constant speed under constant pressure, according to the rate of combustion, although it may be expanded to the highest degree (the conditions being quite different to the heating of a column of air in the open).

The experiment will demonstrate this clearly, and a little thought will show that it must be so, as the expansion of the air by heat results in a less number of atomic particles to the measured volume, while the pressure remains constant to that volume.



The apparatus necessary for the experiment consists of a three-way vessel receiver A, which is composed of glass for convenience of observation. One way is fitted with a tube B, carrying the gas supply, and another and opposite way is fitted with a tube C, for the air supply. This latter tube is kept always open, and thus constant in the area exposed to the pressure of the atmosphere; while the tube for gas is provided with a tap or other regulator B^1, to enable the supply of fuel to be adjusted to the supply of air. The third way forms an outlet for the products of combustion and unburnt or incompletely burnt fuel. This outlet is covered by a disc with a small opening therein, just allowing space for the outflowing current; otherwise down draughts of air will take place, vitiating the results. This, indeed, has been the source of error in many experiments, as it is not always sufficiently recognized that down draughts of air may set up in a chimney, which is supposed to be solely occupied in carrying of the products of combustion. Now, when all other sources of oxygen are cut off than that through the tube C, no combustion of the gas will take place until the two meet; and if the pressure of gas be just regulated to balance the pressure of air, we shall see the peculiar and beautiful phenomenon already alluded to, of a flame balanced

midway between the two orifices for fuel and air. A little more or less pressure or supply of gas, turned on or off at the tap, will move this flame either farther away from, or permit it to approach nearer to, the burner. The nearer the flame is produced to the burner, or, in other words, the sooner the gas takes fire, the more perfect is the combustion; while the farther away from the burner the flame is, or the later the gas takes fire, the less perfect is the combustion. It also follows that when the increased or diminished combustion takes place, the fact is plainly observable to the eye, both in the size and brightness, as well as the position of the flame.

Having obtained this balanced flame, as near as may be, half way between the burner and the air tube (and which I may observe will require a little practice to manipulate), we are ready to proceed with experiments thereon.

Firstly, a Bunsen burner is placed at any convenient point underneath the air tube, when, as the same becomes heated up to the point of delivery, and consequently heats the air passing through it, the balanced flame is observed to move toward the air tube, farther and father away from the gas supply. At the same time it becomes less in size, until it finally, when sufficient heat is obtained, fixes itself on the orifice of the air tube, giving the appearance of air burning in gas, rather than gas burning in air, and is brought down to a very small bead of flame indeed, although the heat obtained or retained in the air at the point of contact is by no means great. When the Bunsen is removed, and time given for the tube to cool, the flame slowly and gradually expands and recedes from the air tube, until it assumes, when the air reaches the former temperature, its original position. It may be here remarked that the experiment incidentally proves that air can be and is heated in its passage through the tube by the act of showing its results on the flame.

By applying the Bunsen to the other tube B, we are enabled to see the result arising from the heating of the gas or fuel. This is again what I had inferred from theory, and is, in fact, the inverting of the former experiment, which gives exactly the reverse conditions to the heating of air. By heating the gas or fuel we reduce, by expansion, the amount of fuel supply, precisely as we before reduced, by like expansion, the supply of air; which heating of the gas is, relatively, equivalent to increasing the supply of air to cool gas. The consequence is that the balanced flame moves in the other direction, and increases both in size and combustion; and if the fuel is much rarefied by heat at great intensity, will set up a vortex motion, which greatly assists the more intimate mixture of air and gas in the operation. It only needs to add, in describing the experiment, that, having obtained the best combustion by heating the gas, the same is lessened again by heating the air in conjunction with such heated gas, exactly as I concluded from the theory herein described.

In that truly valuable book, "King's Treatise on Coal Gas" (the editing of which was so ably performed by your President), we have the received views upon the heating of air, and also of gas, faithfully and accurately set forth and recorded. The chapter written by Mr. R. H. Patterson, in the third volume, is a specimen of conscientious writing, combined with careful thinking, upon the facts and materials at his command. He plainly and frankly puts forward his difficulties, and shows that recorded experimental results are, to him, in many respects, contrary to what might naturally be expected. He comes to the conclusion, from experimental evidence, that the heating of air assists combustion, although from theoretical considerations he expected the reverse. Again, he concludes from like evidence that the heating of gas is of no value, although, on theoretical grounds, this would appear to be a beneficial preparation. His conclusions on the subject may be found on p. 184 of the third volume, and will now be doubly interesting to read.

I think the experiment I have brought to your notice will show the actual and practical results to be really and perfectly in accord with theory; and Mr. Patterson may have the satisfaction of knowing that although he yielded for the time to the supposed evidence of certain experiments, his scientific instincts were, after all, the more reliable guide.

In most forms of combustion we can deal with there are two important considerations of heat—that is to say, there is the heat of evolution, and the heat of transference. The heat of evolution is the direct result of the chemical combination of the particles of carbon, or hydrogen, or their compounds, with the particles of oxygen. The heat of transference is chiefly that which is transferred from these particles to the neutral or passive substances present, either in the fuel or in the supporter of combustion at the time, or in both. In the case of combustion in atmosphere this transferred heat bears an enormous proportion to the total heat evolved. Some idea of this proportion may be obtained by comparisons with heated substances which are familiar. Suppose we take three gallons of water, at boiling point, and add thereto eight gallons of cold water at 32°, mixing the whole together. We shall not find any great heat then in the water, so far as intensity is concerned, although the quantity—neglecting radiation and conduction—will be there all the same. The eleven gallons will reach no higher temperture than 81°, which is a considerable reduction from 212°.

The same process of conversion of intensity into quantity occurs during combustion in air. If we take the case of burning ethene (C_2H_4), known as olefiant gas, we require for the purpose three volumes of oxygen, or 15 volumes of air. There are thus employed sixteen volumes of these two substances, four volumes only of which are engaged in producing or evolving heat. Hence, there are twelve volumes of nitrogen which have to be raised in intensity by, and thus lower the temperature of the four active volumes; forming an equilibrium of the total mass far below the heat of evolution. This may be expressed by supposing ethene to be perfectly burnt in air, and to attain a temperature thereby of 3,000°. If we grant this supposed figure, the same gas burnt in undiluted oxygen, by measured volume, would attain an energy equal to a temperature of 11,820°.

Now, if this twelve volumes of inert passive gas could be raised in temperature prior to combustion, and from an independent source, there is no doubt that 4,455° would be attained, in place of 3,000°, when burnt in air, provided—and here lies the important consideration—perfect combustion should still be possible under the altered circumstances.

But in the case of both furnaces and burners or lamps, the heat for raising the temperature of the air has to be abstracted from themselves, so that, *per se*, it is the same thing whether the heat is directly transferred at the moment of evolution, or, indirectly to the incoming air, prior to evolution. Nevertheless, if this heat (or any part of it) would by necessity be otherwise wasted, a gain might accrue by such prior heating, if nothing else occurred to nullify the result. I learn, however, from the experiment now before me, that heating the supporter of combustion retards or renders such combustion more imperfect; while heating the fuel assists or increases such combustion to a great extent. Both these results proceed from the same cause—namely, the relative expansion of their volumes. The relationship of volumes differ, of course, with the different fuels used; hence the variation in the degree of perfection with which different substances burn in the atmosphere. If we take, again, the case of olefiant gas, the volumes of fuel and air stand as 1 to 15. Now, if we could expand the 1 of fuel to the size of the 15 of air without altering the latter, I conceive we should attain the highest combustion possible, assuming the best temperature of the 15 to be found, as I do not necessarily suppose this to be the ordinary temperature.

I conclude, therefore, that the heating of air at constant pressure *alone*, for combustion purposes, is a decided loss. To heat both air and fuel, at ordinary pressure, provided the latter is already in the gaseous state, will give an advantage over cold fuel and air, or over heated air alone. For, although relatively the two volumes are not altered, there is greater facility for the two gases to combine, the less dense the fuel is; the advantage gained, however, being due to the expansion of the fuel alone, so far as actual combustion is concerned. Finally, heat applied to the gaseous fuel alone, so as to bring its measured volume as near as possible to that of the required volumes of air, at such temperature as may be found best for the purpose, will, I doubt not, give the greatest economy of all. Such being the clear outcome of both experiment and theory.

The condition of things involved in gaseous firing by secondary combustion is one which favors more than another the heating of air—or, more correctly speaking, is one which is the least unfavorably affected by the process, for the reason that combustion therein being a divided operation, the air for the purpose is admitted at two separate stages, giving time for the expansion of the fuel in the monoxide form. The two volumes of fuel and air, therefore, stand in the secondary furnace as 1 to 5, in consequence of only requiring one molecule of oxygen—a degree of discrepancy which, in its comparative smallness, has doubtless had much to do with the possible economy attained in this way.

To heat the air under pressure, as in the case of the hot blast, becomes highly advantageous, as the two volumes are thereby relatively altered in value to the extent of the pressure on the air; added to which the large mass of air, in present practice at least, allows of much heat being restored to the furnace.

It is no part of my intention in this paper to enter into the question of the *amount* of heat capable of being conveyed by the air from the waste gases—that has been, to a great extent, dealt with in the articles already alluded to; but to point out that as the conveying of this heat is a work which interferes seriously with the efficiency of the carrier, in performing its legitimate and far more important function of supporting combustion, it will, therefore, be well to seek for a more satisfactory means of retaining the heat within the furnace or flame, or of returning it thereto, as the case may be. Thus, though the present system involving the heating of air has been a step in the path of progress, it will be seen that there are greater possibilities still to be attained, the pursuit of which, I believe, will result in examples of both gas lighting and gas-furnace firing far superior to anything which has, up to the present, been accomplished.

Discussion.

Mr. W. Sugg (London) said he rose to ask a question which might assist the discussion. In the beautiful experiment which was shown on the diagram there did not seem to be any indication of the thermometer having

been placed in the interior of the bulb to indicate the temperature. Mr. Gadd said he warmed the air and gas by means of a Bunsen burner at the end of the pipe; but, unless one knew the temperature in the globe, one could not form any idea of the temperature of the air when it issued from the aperture inside the globe.

Mr. C. Hunt (Birmingham) said the members would all be prepared to accept the accuracy of the experiment Mr. Gadd had been kind enough to show them, and it was not difficult to understand that, under certain conditions, heated air might retard combusfion; but the practical question was, how did this affect matters which were of importance to them?—how, for example, did it affect the action which took place in a regenerative furnace, or support the conclusion Mr. Gadd had arrived at? In order to answer this question it would be necessary to ask another—viz., what were the proofs of perfect combustion that would be acceptable to Mr. Gadd? He took it that if they analyzed the waste gas, and found no trace whatever of carbon in a combustible form, but rather a slight excess of oxygen, then there was perfect combustion. These conditions were found by analysis to prevail in a properly regulated regenerative furnace; and therefore he maintained that heated air was no detriment whatever to its action in the manner suggested by the author of the paper.

Mr. J. P. Leather (Burnley) said this was a most remarkable paper. It was remarkable because Mr. Gadd deduced from theoretical considerations an opposite conclusion to that which he should deduce from those theoretical considerations; and he gave an experiment which proved the very opposite to that which he concluded from it. He said that in heated air there were fewer molecules in a definite volume. This was perfectly true; but as long as the pressure remained the same, it was made up for by the speed at which they traveled, according to the ordinary kinetic theory of gases. If the absolute temperature of the air were doubled, the speed of the molecules and the number of times which they impinged on the molecules of the fuel were doubled; and, consequently, the intensity of the combustion was increased. Then he compared the decrease in the density of the gas by reducing the pressure. Now, it was well known that, by the reduction of pressure the luminosity of a flame was decreased; but this did not apply in the present case, because it was compensated for by the increase in the speed of the molecules of the air. Next came the question of the experiment. He took it that heating the air increased the intensity of combustion, as also heating the gas did. When the air was heated the flame approached the air naturally, because this was the place where it could burn quickest. Then Mr. Gadd said there was incomplete combustion, and the flame became small. Of course it did, because the gas drove the flame back, and some of it escaped unburnt. But let him take it the other way about. When he heated the gas and not the air the flame approached the gas, because there the combustion was more intense and quicker—there the combustion of the gas was perfect, and the combustion of the air imperfect. But it was imperfect in both cases, not because of the heat, but because the heat really produced more intense and quicker combustion in each case. These considerations seemed to him to nullify all the conclusions of the paper.

Mr. C. W. Folkard (Chiswick) thought the result of the experiment was capable of easy explanation. When the air was heated there was still the same chimney draught, and therefore the same volume, but less weight of air (because it was more highly expanded) was available for combustion. Under these circumstances, as Mr. Leather had pointed out, the combustion of the gas was necessarily imperfect, because there was not enough air supplied. If Mr. Gadd were to supply the same weight of air under all circumstances—in the one case heating it, and in the other not—the experiment would be perfectly fair. It was analogous to the case of supplying producer gas. If a cubic foot per minute of such gas were supplied to do a certain amount of work, a low temperature would be obtained, and a much lower temperature than with a cubic foot of coal gas; but if a sufficient quantity of producer gas were supplied, any required temperature might be obtained. He would ask Mr. Gadd how he would explain the action of the Siemens regenerator furnace for steel making. The air there was only under the drag of the chimney; but there was not the slightest doubt that a greatly increased temperature was produced by heating the air before combustion. As to the hot blast under pressure being under different circumstances altogether, he could not think it was so; for, although the pressure at which the hot blast was supplied might be 2 pounds or 3 pounds per square inch above the atmospheric pressure, compressed air, when subjected to heat, expanded quite as much as air at ordinary atmospheric pressure.

Mr. J. P. Leather (Burnley) asked permission to add a fact which elucidated this question. Many years ago he saw an experiment of this character performed by Professor Thorpe. When the air admitted to an ordinary Bunsen burner was heated, it produced luminosity in the Bunsen flame, even although the quantity of air was not diminished, but the flame became actually smaller. It was well known that, if the air supply to a Bunsen burner were stopped, the flame became luminous but larger; but in the present case the flame became smaller when supplied with hot air, but more luminous. It was a different kind of luminosity to the ordinary luminous flame of gas, and was due to the much greater intensity of combustion in the flame.

Mr. W. Foulis (Glasgow) said the paper was perhaps a little too scientific for him to discuss; but there were one or two phenomena to which he would ask Mr. Gadd's attention, and which might have some effect in altering his opinion. It was very well known that, in the Siemens regenerative burner, when the burner was first put on (before it was heated up), the combustion was exceedingly imperfect, and the flame had to be turned down to prevent carbon being deposited. Gradually, as the air was heated up, the combustion became more and more perfect. In all regenerative furnaces that he knew of, where coal gas was used, both the air and the gas were heated. Where the gas was already at a high temperature, as is the case with gas made from coke, there was no necessity for heating it; but in the case of coal gas it was heated. The experiment to which the author seemed to attach so much importance had already been sufficiently commented upon by previous speakers. By heating the air in the tube, the quantity which found its way into the bulb was diminished; but if the size of the tube were increased in proportion to the expansion of the air, the whole of the results would be altered. In making a regenerator furnace or burner for practical purposes the flues were made large enough to take in hot air sufficient to supply the flame. Mr. Gadd concluded that heating the air at constant pressure alone for combustion purposes was a decided loss; but if it were the case, as stated in the paper, that, by heating air, facilities were obtained for the combination necessary for combustion, then if they had a sufficient supply of air, and at a high temperature, they must have more perfect combustion, and a higher flame temperature, than when using cold air. There seemed to be some confusion of ideas with reference to heating air under pressure or under blast. Without entering into this question, he wished to point out that, when the hot-blast furnace was first introduced, the pressure was only about 1 lb. or 1½ lbs. above the atmosphere—a pressure which was not sufficient to account in any way for the benefits which were undoubtedly derived from the heating of the air.

Mr. D. Bruce Peebles (Edinburgh) suggested that to make this apparatus complete a small gasholder should be employed, both for the air and for the gas, in order to insure constant pressure. If this were done something like reliable data might be obtained. In this case there was a simple opening to admit the atmospheric air, while the gas had a definite pressure applied to it. If the same pressure were applied to both air and gas, measured quantities of each might be taken, and the action of the apparatus would be much more reliable and complete.

Mr. Sugg remarked that the discussion must be very much limited by the fact that there was no indication of the temperature inside the bulb. It was perfectly clear that, under ordinary circumstances, the temperature of the issuing air must be the same as the temperature at the end of the tube inside the bulb. It did not matter what was done to it outside, especially with such small quantities.

Mr. D. T. Livesey (Aldershot) asked if Mr. Gadd adopted any means for ascertaining whether there were complete or incomplete combustion. The luminosity or non-luminosity of flame was, he said, not sufficient.

Mr. W. Carr (Halifax) asked whether Mr. Gadd deduced from this experiment the conclusion that the aggregate of heat obtained was not increased by the heat of the air supplied for combustion. If so, it was contrary to all his previous experience. With reference to the effect of heated air on the luminosity of flames, it became very much a question of the mechanical conditions by which the flame was surrounded. In the case of regenerative burners, they knew the illuminating power increased as the air supplied was increased in temperature; but whether it was owing to the heat or to the conditions being more favorable at the time the heat was obtained (the burners being constructed for this purpose), they did not know. This, however, he did know—from watching the flame of one of these burners over and over again—that when first lighted there was some difficulty in obtaining combustion; but this arose from the fact that the draught had not been established in the burner. When the chimney became hot, and the draught was established, the flame burnt vigorously at first with the cold air getting to it, and its luminosity was somewhat low. As the heated products of combustion passed through the burner, and the air supply became hotter, the length and luminosity of the flame increased as the operation went on, until the burner attained its maximum effect. The question of obtaining heat for the purpose of heating retorts and the distillation of coal was the most important; and his idea had always been that if they took a quantity of fuel matter, in the form of gas or otherwise, at a certain temperature, and the air supplied for the combustion of that fuel at a given temperature, they obtained a certain heat result from the products of combustion. If they doubled the temperatures of both the fuel and the air they would get a very much greater effect, for the simple reason given by Mr. Leather, that ignition and combustion took place with much greater activity and velocity at a high than at a low temperature. They had first to deal with the initial tem-

perature of the gas and of the air; then they had the heat of combustion added to these. Whatever the temperature might be at the beginning, the results were higher if the heats were higher to begin with; and the resultant temperature must necessarily be the heat of combustion *plus* the heat of the gas and fuel to commence with.

Mr. Denny Lane (Cork) thought that a little confusion had arisen from the employment of two words which had frequently caused some confusion before—the words, "heat" and "temperature." They were two totally different things. "Heat" meant the total quantity of calorific energy developed; and "temperature" meant the degree at which it was developed. There could be scarcely a doubt that if they took any combustible and burnt it efficiently the whole quantity of heat added to any heat they had before would be precisely the same, no matter at what temperature the combustible was burnt. The temperature would, of course, be raised if they began with the combustible hot and the supporter of combustion also hot. The heat produced was that arising from combustion *plus* the temperature previously existing in the combustible and in the agent that supported the combustion. He did not think any change in the temperature at which this was conducted could in any way increase or diminish the actual quantity of heat developed by the combustion. It simply made a difference in the temperature.

Mr. C. Gandon (Sydenham) said he should like to mention the case of a burner which seemed to give results rather contrary to the contention of the author of the paper, being simply a double cylinder Argand burner with the lower end of the outer cylinder closed, so that the air to supply combustion had to pass between the two cylinders, and thereby become heated. He could well remember trying the burner on several occasions. When first lighted, and before the air became hot, with a certain consumption of gas a definite height of flame was obtained. In a minute or two afterwards it was necessary to turn down the gas supply and consume considerably less gas, or it began to smoke; clearly showing that there was not sufficient air supplied to it. The illuminating power also agreed with the height of the flame. If, therefore, with a smaller consumption of gas more light (or the same light) was obtained, it certainly seemed to show that, in practice, there was some advantage gained by heating the air, whatever the theory might be against it.

Mr. Gadd, in reply, said he had listened with great attention, and also with some disappointment, to the criticisms which had been passed on his paper. He thought he had made his position clear; but, unfortunately, most of the gentlemen who had spoken had entirely misinterpreted his position. He could, however, easily understand why this was so. It had possibly been assumed that he had been endeavoring either to resuscitate some other theory or to demonstrate something which had gone before; but he had no such intention. He simply wished to bring forward an experiment showing certain effects of heating air on combustion *per se*. He wished it to be considered apart from anything else. Perhaps he was somewhat to blame for having alluded to former inquiries; but he only did so to show why he had taken up the subject. Mr. Sugg thought it important to know accurately the temperature inside the bulb; but if Mr. Sugg watched the experiment, and the deduction he wished to draw from it, he believed he would alter this view. Of course, for accurate scientific investigation it might be advisable to know this; but it was not necessary for the purpose in view. When a man knew he was cold he did not need to know the exact temperature of his body; and the same when he felt hot. It was very important for scientific inquiry to know these temperatures; but it did not alter the fact whether the man felt hot or cold. He (Mr. Gadd) hoped some investigator within the Institute would pursue the subject further, and take up the question at the point at which he had left it. Mr. Leather made some objections to the theory; but he would find, when he examined the experiment, that what he said would hardly apply. Mr. Leather spoke about the speed of the molecules; but in the paper he (Mr. Gadd) was not speaking about this at all. He referred to the speed of travel of the volume of air, and he did not see that the speed of the molecules affected this portion of the question at all. The speed of the molecules in their orbits was involved in other departments than the one to which he was referring. The speed of the molecules came into operation first in the act of expansion, and, second, at the moment of evolution of heat itself; because the speed was finally determined by the inrush of particles coming together, forming the compound by the process called combustion, just as the speed of a comet was influenced by its inrush to the sun, or as a meteor falling to the earth. Mr. Leather very properly raised the question of the degree of perfection of combustion in the different stages of the experiment. He (Mr. Gadd) had described it as a "balanced flame of imperfect combustion." When at its best, with the coldest air, he regulated the orifice to such a size that it still gave very incomplete combustion; and when he analyzed the products there was a portion of unburnt gas coming away. It was imperfect and incomplete in the first instance; then it was a question of increasing or decreasing the amount of perfection; and this was just what was done. On analyzing the products the amount of unburnt gas became greater and greater, just as the tube became hotter and hotter. Mr. Folkard had some difficulty about the quantity of air; but the volume of air was a very different thing to the weight. Air might be measured by volume or by weight. If it was weighed, 1 pound of air expanded by heat would occupy a very large volume as compared with cold air; but, when passing the air through tubes, the tubes did not expand with the air, and as a consequence the volume of the air became gradually lighter as it expanded. Mr. Folkard asked how the question affected the new Siemens regenerative burners. The cold air must go close up to the hood, which really formed a portion of the enclosed passage, although enlarged in size; and the heated air would be expanded throughout the whole length of the passage. It was assumed by many speakers on the previous day that the whole of the air required for combustion came through the heated passage; but this was a point to which he should demur. The air would come from those places where it was obtained most easily; and the air close underneath the jet was the easiest place from which to supply air for combustion. His explanation of this burner would be that a great portion of the air for combustion came from the cool portion, and the heated air above filled an important function which had not yet been clearly seen. It was well known that a white plate held over a lamp caused a deposition of carbon, owing to the sudden reduction of the temperature of the flame. Now, if the top of the flame were plunged into a heated atmosphere, there would be an insulation of the heat and prevention of the rapid cooling at the fringe of the flame. This, he believed, was one great point in the heated air for such burners—that it prevented the cooling of the flame rapidly; and he believed this was the real function played by the heated air in the Siemens burner. In cases where incomplete combustion occurred the carbon escaped, or had a tendency to escape; but the heated air above also provided sufficient oxygen to complete what would be otherwise incomplete combustion.

Mr. Folkard said he referred to the regenerative furnace, not to the stove and lamp.

Mr. Gadd said Mr. Foulis had referred to the smoke arising from the regenerative burner when first lighted; but there was nothing remarkable about this. If a fire were started before the chimney became warm it also would smoke. By heating the passage the delivery of air to the flame was reduced in weight, not in volume. Although the volume was the same, and the constant travel of the volume just the same, the quantity of air was reduced; and he did not know that, even if a gasholder were employed, the pressure would be equally constant. He thought Mr. Foulis had altogether misunderstood his paper. He entirely agreed with what Mr. Lane had said If they had heat at any temperature, the most minute portion of heat added to this increased the total quantity of heat; and to the extent that heated air was carried forward into the furnace, it increased the total quantity of heat in the furnace at the moment. What he wished to convey was this—that it was possible there might be a better way of conveying heat back to the furnace or retaining it therein. It was with the view of future investigation that he had brought forward this question. Heating air was a step in the path of progress; but he did not think it was the final step. There was something further to find out; and it was in this spirit and with this object that he had read the paper.

The President said they had all listened with interest to Mr. Gadd's paper, and whether his views (which might appear to be heretical) were right or not, it was well to bear in mind that Professor Tyndall himself had said that much was yet to be learnt on this question of heat and of heating air. This remark was necessary, as some of the speakers had perhaps been inclined to express themselves as though the actual facts were settled. Gentlemen might hold quite different opinions to those which Mr. Gadd had expressed; but it was well to have both sides presented to them. In any case, he considered Mr. Gadd's paper a valuable contribution to a subject in which they, as engineers, were very deeply interested. They must not give up this question of regeneration and the heating of air until they had looked at it from different points of view and were quite satisfied about it in their own minds. There was a great deal that was not yet cleared up on the subject; and they were much obliged to Mr. Gadd for his kindness (not being a member) in coming and giving his ideas on the question from a purely scientific standpoint.

The New Works of the Australian Gas Light Company.

A late issue of the Sydney *Morning Herald* contains the following interesting and "newsy" sketch of the new gas works now in process of erection at Mortlake, near Sydney:

The extraordinarily rapid growth of Sydney and the suburbs during the past few years has been felt probably by no public body or institution more than by the Australian Gas Light Company. As street after street and road after road have been added to the metropolitan area, so the gas mains have followed in their wake; until at last even the more distant suburbs have had their wants supplied. Some idea of the extent of the company's operations may be gathered from the fact that their area of supply requires probably

not far short of 225 miles of pipes. The whole of this vast area is supplied with gas manufactured at the chief works at Darling Harbor. Only five years ago the gas requirements of Sydney and the suburbs were so moderate that the operations of the company were comparatively limited. At that time the total storage plant consisted of four gasholders at the head station at Darling Harbor, four at the Haymarket, and two at Woolloomooloo; the combined capacity being 1,100,000 cubic feet. At various times since then some of the smaller holders have been dispensed with, and others have been removed to make way for larger ones; so that now, while there are only seven holders in use—*i. e.*, two at the head station, three at the Haymarket, and two at Woolloomooloo—yet the holding capacity has been just doubled; that is, 2,200,000 cubic feet. There is thus shown an actual increase in the demand for gas of 100 per cent. in five years. The company also possess two other works separate and distinct from their head station—viz., at Five Dock and Balmain respectively—and at each the increase has been exactly in the same porportion. Whereas in 1880 the amount of storage room required at each place was only 40,000 cubic feet, it is now 80,000—an increase which necessitated the erection of two more holders. But during the period mentioned, and more especially the last twelve months, the mains of the company have been laid down in distant suburbs to such an extent that houses nearly seven miles away from the head station are now enjoying the benefits of gas light. These suburbs are, of course, daily becoming more densely populated; and the gas mains are being constantly tapped to supply the new houses. What with this ever-increasing demand for gas, and the growing use of gas stoves, the works at the head station have been taxed to their utmost extent for some time past. Additions and extensions have been continually made to meet the public requirements. The retort house has been lengthened—bench after bench of retorts being added, and extra purifiers have been provided—indeed every appliance that science has furnished has been brought into use. But at last the limit of space at the head station has been reached, and there is now not an inch of room left for further extension. The directors of the company, foreseeing what, sooner or later, must inevitably occur, about two years ago took the wise precaution of purchasing a suitable block of land whereon they might indefinitely extend their operations. Events have proved that they were not a moment too soon in their action, for the new works can only just be finished in time to meet the expected requirements of next winter. The importance of this step, and the magnitude of the works undertaken, may perhaps be imagined when it is stated that no less than £150,000 will be expended in carrying out the scheme. Although this large amount of money will be required for the works now in progress, yet sufficient space will remain to extend them almost indefinitely; everything being designed with a view to meet all possible requirements, far beyond the necessities of the present generation.

The site selected for the new works is at Mortlake, on the southern side of the Parramatta River. It comprises altogether 60 acres, with an excellent water frontage on two sides. Of this area 40 acres will be occupied by the works, and 20 are set aside for a fresh water reserve. As the ground for the former rose from high-water mark to 60 feet at the boundary, a considerable amount of levelling had to be done. The space required for the yard—in which will be placed the retort house, engine, exhauster, and meter houses, purifiers, washers, scrubbers, condensers, etc.—is 5 acres, and to obtain a level for this, at 15 feet above high water mark, about 38,000 yards of material, mostly sandstone, had to be removed. All this, however, was utilized for reclamation purposes, by which a large quantity of land was obtained. The most important building will be the retort house, which is being built of brick, on rock foundations. Its length will be 280 feet; its width 70 feet; and its height to the spring of the roof 46 feet. On either side of the house will be a coal store, of equal length, 40 feet wide and 20 feet high, with a combined storage capacity of 8,000 tons. The roofs will be of iron, covered with slate. The house will contain 24 benches of 9 retorts; the whole being capable of making 2½ million cubic feet of gas daily. The floor will be 10 feet above the ground level; and the retorts will be fed from the charging floor, the intervening space being used for a coke store. The charging and drawing of the retorts will be done entirely by West's machinery, worked by compressed air. Connected with the retort house, at the west corner of the yard, is being constructed a T-shaped jetty, built on piles driven in rock. The jetty will be 160 feet long, and range in width from 168 feet at the head to 25 feet at the commencement. There will be two floors or landing stages. The top, 35 feet above high-water mark, will be used for the landing of coal; the lower floor, 20 feet beneath, will be on a level with the yard, and used for the discharge of residuals. The coal will be taken out of the colliers by a steam crane, at the rate of a ton per minute, tipped into trucks, and conveyed by a small locomotive engine into the stores. This engine will run along rails diverging from the jetty to the two coal stores, over a curved viaduct 20 feet high, built of cast iron columns and wrought iron girders. Adjacent to the retort house are two tanks, 50 feet in diameter, and 20 feet in depth, cut out of the rock, for the reception of tar and ammoniacal liquor, each capable of holding 250,000 gallons. The purifiers (the foundations for which are also cut out of rock) are each 30 feet square and 6 feet deep. The engine house, which will be built of brick, on rock foundation, will be 51 feet in length, and 54 feet in width. A cast iron tank, resting on wrought iron girders, and supported by cast iron columns, will cover the entire roof area. Two engines will be erected for present purposes; but room will be available for four more. These engines are required for working the exhausters. Adjacent to this house will be a boiler shed, a chimney 80 feet high being erected in connection therewith.

The gasholder tank has been sunk at the extreme boundary of the company's land, and is about 460 yards distant from the retort house. The dimensions of the tank are: Diameter, 186 feet; depth, 37 feet 3 inches. It was excavated partly through rock and partly through ironstone, the sides above the rock level (which varied considerably) being built up of brick 9 inches in thickness, and filled in with concrete from 1 foot 3 inches to 2 feet 6 inches in thickness. All the brickwork has been rendered with cement. The annular space cut out of the rock is six feet in width; the center of the tank being, of course, left and covered with 6 inches of concrete, which was also rendered. The top of the center has been fitted with timber trussing, to support the crown of the holder when it is down. The rim of the tank is covered with a stone coping; and the foundation stones for the standards (24 in number) are 7 feet square, 18 inches thick, and upwards of 6 tons weight each. The foundations for these immense blocks of stone are formed by piers of concrete 7 feet square, extending down to the rock. In each pier are four bolts, 12 feet in length and 2½ inches in diameter, for securing the standard base to the stone. The inlet and outlet mains are 24 inches in diameter. The holder itself will be a telescopic, triple-lift; the respective diameters being as follows: Inner lift, 179 feet; middle lift, 181 feet 6 inches; outer lift, 184 feet. Its weight will be 1,300 tons; and, when filled with gas, it will rise to a height of about 110 feet, when its total capacity will be 2½ millions cubic feet. The standards are of wrought iron, secured in cast iron bases, and will be braced together by tie-rods and lattice girders to form the guide frame. Their height will be 112 feet irrespective of the cast iron finials which will surmount them. The tank is sunk in ground 45 feet above the yard level; and the holder will be filled with gas running through mains 36 inches in diameter from the outlet of the meter to the inlet of the holder. Adjacent to this portion of the works will be the manager's offices and the governor room.

The remaining work under construction at Mortlake is the fresh water reserve above referred to. The dam is composed of an embankment 15 feet above high-water mark, with a puddle wall running through the center of its entire length, and extending from the solid rock to the top. About ten of the 20 acres are being prepared for the reserve, which it is estimated will have a capacity of at least 10 million gallons of water. The site selected is admirably adapted for this purpose, the land being low and surrounded by hills, which provide a catchment area of somewhere about 150 acres, all the surface drainage of which must naturally flow into the reserve.

Another large undertaking in connection with these works is the laying of cast iron mains for the delivery of gas into Sydney. No less than 5½ miles of these mains are required; and when it is stated that the total weight amounts to more than 4,800 tons, some idea may be formed of the work involved. The mains are 36 inches in diameter, and are laid at a depth of 2 feet 6 inches. All but 2,000 yards of the distance has been finished; and the whole would have been shortly completed had it not been for the exigencies of the Government, who required 500 of the pipes for the works in connection with a temporary water supply. Fresh pipes, however, have been cabled for from England, and they will all be laid and ready for use by the time the works are finished. Larger mains are also about to be laid to replace smaller ones where required to meet the continually increasing demand for gas.

It need scarcely be stated that nearly the whole of the material for the immense works now in course of construction was manufactured in England. For considerably more than a twelvemonth vessel after vessel has arrived bringing large consignments for the company; four or five ships, indeed, being wholly chartered for the purpose. No less than 9,000 tons of manufactured iron have been brought in this way, lightered into punts, and landed at the temporary jetty at Mortlake.

The erection of the gasholder (which will be the largest in use on this side of the world, and is the most extensive undertaking of all) will be carried out by the company, and is expected to be finished by the end of next March. The remaining work will be the erection of the iron viaduct, and the building of the retorts, both of which will be done by the company's workmen. If no untoward event occurs the works will be completed in time to meet all the requirements of next winter.

The Peruvian Petroleum Field.

According to a contemporary, the existence of petroleum in the land of the Incas has been known for many years. At numerous places in the Andes Mountains the outcroppings of oil are plainly to be seen. Shallow pits, dug for various purposes, have speedily filled up with the black, greasy product, for which the natives could find but limited use. At Mal Paso, on the Pe-

ruvian coast, the mountain range forms part of the shore line of the Pacific Ocean, and from the huge cliff, whose rocky front has been broken off by the ceaseless dash of waters, oil has been seeping for centuries. But no fire worshipers were in this part of the world to ignite the inflammable oil, and watch the weird effect of an ocean of flame. All about this region are to be found monumental remains of the ancient Peruvians, whose civilization is still the marvel of the antiquarian, but nowhere have any evidences been discovered to show that the deposits of crude oil were mined or used by this intelligent and mysterious race.

The petroleum field of Peru, as at present defined, consists of a small area of territory, in the department of Piqua, in the northwestern part of the country, containing three producing oil wells and a refinery. About 19 years ago Mr. Fred Prentice and a number of oil region capitalists invested considerable money in fitting out an expedition for developing the petroleum deposits of Peru. The result of this exploration is shown to-day at the village of Zoretus, on the Pacific coast, twenty miles south of Tumbez, where 15 or 20 wells have been drilled, and a refinery of three stills erected. An Italian gentleman, by the name of Piaggio, who resides at Callao, is now the owner of the wells and the refinery.

During the spring months of the present year Mr. A. A. Perkins, of Bradford, an expert in everything that pertains to the sinking of artesian wells, was engaged by Mr. Piaggio to come to Peru and drill a couple of the wells to a greater depth, with a view to obtaining an increased output of crude. Mr. Perkins sailed from New York to Aspinwall late in April. Crossing the isthmus on the Panama Railroad, a steam vessel took him to the mouth of the Tumbez River, a small harbor on the northern coast of Peru. From the steamer a rowboat is required to conduct the traveler up the Tumbez River to the village of the same name, a small place of about 800 inhabitants. A bridle path over the mountains leads to Corrales. Here the path winds along the bottom of the foothills to La Cruz, where it takes to the beach. A four-mile ride along the shore and Zoretus, the place of his destination, is reached.

Mr. Perkins found that of the 15 or 20 wells that had been drilled since the advent of Mr. Prentice, none had been sunk to a depth of 500 feet, and nearly all of them were pretty thoroughly plugged with broken-down tools and old iron. One producing well, doing about 10 barrels a day, supplied the refinery, which was fired up about once in three weeks, or when sufficient oil had accumulated to make the operation worth while. This well was 300 feet deep, and produced a black oil of 36° gravity. Mr. Perkins' first employment was piecing together a set of tools, from the remains of what had been brought there in previous years. He found drilling operations in charge of an intelligent Canadian, who had been in the country for 15 years, and who was thoroughly acquainted with the language, manners and customs of the natives. The old style of drilling with the centerbit and reamer was strictly adhered to, and Mr. Perkins' intentions of drilling with a club bit were derided and believed to be an impossibility by the Canadian and the workmen he had trained to assist about the wells. A well 430 feet deep was immediately drilled to a depth of 480 feet, and a green oil of 43° gravity discovered. The well is now pumping 20 barrels a day. The black oil is generally found at 130 feet, where it begins to seep out from the rock. About 70 feet of casing is used to keep the well from caving, and not from any desire of shutting out the salt water. The rock seems thoroughly saturated with oil all the way down as far as the drill has yet penetrated.

Mr. Perkins' next undertaking was at another old well, 280 feet deep, which at one time had produced 100 barrels of black oil per day, but which was now entirely exhausted. His greatest difficulty was in piecing together a derrick. There is no timber of any value in the country, and all other rigs had been erected without any main sill. The Sampson post had been set directly in the ground. No sand reel was used, but instead the tools were pulled out and a hollow tube screwed on which was used as a sand pump to remove the sediment.

Mr. Perkins' new rig was 48 feet high, and he used a sub-sill in which the Sampson post was inserted. A sand reel was a feature of the new rig entirely unknown in this country before. He removed the casing from the old hole and reamed it down to the original depth. He used 2¼-inch tools for the small hole and club bits. Tools of this size had previously been used solely for drilling the big hole. The last well drilled at Zoretus required seven months. With the improved facilities Mr. Perkins soon put the well down to a depth of 343 feet, and states that with a full oil region outfit and oil region drillers there is no reason to prevent wells from being sunk with as great rapidity in Peru as in Pennsylvania. The well drilled was expected to make a 20-barrel pumper, and completed his engagement in this primitive region.

The oil refined by Mr. Piaggio at Zoretus is put up in cases containing two cans of five gallons each. It readily commands $4.50 per case at Callao, where a good quality of American refined is sold at 50 cents a gallon. Callao, the principal commercial city of Peru, is 800 miles south of Zoretus. The refinery now has a supply of about 40 barrels of crude a day from the three producing wells. There are three iron tanks at Zoretus, each of 3,000 barrels capacity. The refinery at the present time is only using one of its hundred barrel stills. Petroleum refuse is used for fuel, and small quantities of wood, which is brought from the mountains packed on the backs of the small but strong and willing burros. Rain seldom falls at Zoretus, and the water supply is obtained from the ocean. Marine boilers are used about the works and in drilling the wells. The condensed steam from the exhaust pipes is used for drinking. The refinery is in charge of a native Peruvian, who is called the "administrator." A tin shop, in which the cans are made, also employs native workmen.

The temperature at Zoretus never rises above 90° F., and rarely falls below 60°. The trade winds strike the place, and their steady breeze is at once refreshing and exhilarating. No more romantic site for an oil well could be imagined or desired. On one side, within 100 yards, the great Pacific dashes its breakers with never ceasing roar against the shore; on the other the snow-capped peaks of the Andes lift their rugged forms.

Mr. Perkins is of the opinion that an abundant supply of petroleum can be obtained at a depth of 1,000 feet. A market could be obtained for it in supplying locomotives and steam vessels with the liquid fuel. Coal is scarce and dear, costing $16 per ton. The country about Zoretus is barren, but in the vicinity of Tumbez numerous haciendas bear witness to the fertility of the soil. All the land has to be irrigated. Cocoanuts, pineapples, bananas, etc., are raised in abundance.

An Experiment in Gas Making, and the Results Thereof.

By Frederic Egner.

Theories being changeable while facts are unalterable, it is of course within the knowledge of every well informed person of the present generation that many things which once, or in our youthful days, were considered impossible and contrary to all known rules of science or chemistry—in short, then held as visionary—are now accomplished facts. It being quite needless to cite examples of the correctness of that assertion, the writer presupposes, in consideration of the results detailed below, and remembering what is said above, that the reader may kindly overlook, and consequently make due allowance, if the accepted or generally entertained theories of the present day do not coincide with the "hard facts" presented in the succeeding lines.

The President of one of our Western gas companies, who, by the way, is a gentleman possessed of great practical experience in the duties of gas maker, manager, and executive head of gas companies, and who also may be enrolled amongst the ranks of our "entirely successful men of business," remarked at one time that he thought gas might be obtained from coal, in a useful commercial form, without placing it into retorts at all. He did not believe in retorts, although he was obliged to use them simply from lack of a better vehicle or vessel; but notwithstanding their antiquity and undoubted value he yet thought coal might be distilled by the direct application of heat. He had expended large sums of money in attempting to accomplish the desired object; and though not successful in the endeavor, so firm did he remain in his belief that time and experiment would solve the riddle that he persisted, and would reject no plan submitted for his inspection, provided the same had reason as an element in its foundation. He called his pet theory "slacking coal by heat." Some laughed at "the old man," while others, thinking seriously over the project, acted on it; though the original investigator, in the person of the gas president alluded to, knew nothing about the inception of the experiments here to be presented, and as a consequence is not conversant with the results obtained, since this paper will likely furnish him a first intimation that they have been made at all, it is but just to state that his remarks in regard to the subject led to the present attempt to put his theory to practical test. As to whether the results so far obtained are to be classed in the category of successes or failures, of course the critical and painstaking reader can and will decide for himself.

The first trial was conducted by means of an apparatus of which the following furnishes a fair description. A cylindrical shell of boiler iron, 7 ft. 3 in. diameter and 20 ft. high, lined with fireclay blocks 12 in. deep throughout; a grate 2 ft. from bottom; a door in ashpit; a door on line with grate; and a door 10 ft. from the bottom. Four feet above the grate the shell, or generator let us call it, was pierced by ninety-six 1-inch pipes, which admitted air to the inside, but which could be closed at will. Four feet above these tuyeres were the outlet pipes, two in number, of 8 in. diameter each. These pipes ended in a hydraulic seal or wash-box, from which a steam-jet exhauster removed the gases made, and forced them on through a condenser, scrubber, purifier, and meter. There was a ¾-inch steam pipe in the ashpit, and a coal-hopper, with measuring drum and valve, on top of the generator. The foregoing was not the original design of the apparatus in all particulars, but was sufficiently like it to answer for a trial.

The operation was to be thus: A fire being started on the grate, coke was to be fed into the generator to a depth of 8 feet. The air entering under the

grate would be converted into carbonic oxide by the time it reached the line of tuyeres, where, more air being admitted, the heat generated by the combustion of that gas would be sufficient to greatly heat the coke above the tuyeres to a height of at least 30 to 36 inches. This last air, having to pass through so deep a layer of incandescent coke, would also be converted into carbonic oxide before reaching the outlet pipes. Steam was to be admitted under the grate, and this steam would be partly or wholly decomposed in its passage upward. Some of the free hydrogen generated would combine with the nitrogen admitted with the air and form ammonia. Fresh coal was to be dropped onto the heated coke in the generator continuously in small quantities; and as the gas was extracted from it the coke was to be removed from the grate, also in a constant ratio, so as to retain the depth of carbonaceous material in the generator at about the same level at all times. The exhauster was not only to remove the gases made above the fuel, but was, at the same time, to create an indraught of air through the tuyeres. As the application of the heat was direct to the coal, it was thought there would not be a sufficient production of the objectionable gases to injure the general results. The coal was to be fed, and the coke removed, by suitable machinery. When the apparatus was started it was found to operate at first just as had been expected, except in two particulars. It was found that as the coal was coked it formed one large lump which, after a while, prevented the further feeding of coal. This was overcome by introducing stoke holes on top of the generator, and breaking up the coke from time to time. The other difficulty was that not all the tar made was converted into gas; and that objection was also remedied.

The results obtained were not discouraging, so that one improvement after another was made, until now the apparatus seems to be about ready to stand on its merits. The original generator was reduced in size, so as to be 3 ft. in diameter and 11 ft. 4 in. high inside. The reason why this reduction in diameter was made was owing to the fact that the exhauster used was not of sufficient capacity to take away all the gas made, and it was cheaper to reduce the generator than to purchase a new exhauster. It was also found that the illuminants in the coal were not present of themselves in bulk sufficient to carburet the gas made in the generator, and therefore a bench of three oil retorts was added.

The next design caused the gas from the generator and retorts to be drawn together through two fixing retorts placed in the same bench with the oil vessels. Before the fixing retorts were added the results were as follows:—giving, of course, the averages: 11.2 pounds of Youghiogheny coal (not lump, but slack), 3.84 gallons of gas naphtha (62°), and 1.33 pounds of gas coke produced 1,000 cubic feet of gas of from 18 to 19 candle power. Coke was the fuel used in the oil bench. Only gas coal was used in the generator. The steam was supplied by the works, and the fuel to raise that is not included in this statement; but it could not have been more than, if as much as, 1.5 pounds of coke per 1,000 cubic feet. Gas was made at the rate of 6,500 cubic feet per hour. The labor required was one man; and it was evident that he could have attended an apparatus of double the capacity of the experimental one. The steam used was not superheated, but was taken from the boiler of the works located at a distance of close on to 100 feet from the generator. Since the fixing retorts were decided on no gas has been made in the apparatus; but the results with the fixing retorts will certainly not be less than those obtained without them. An ordinary coal gas bench was used in which to make the oil gas. Three of the retorts were used in connection with this apparatus, while the other two (it was a bench of fives) continued to make coal gas, which, by a suitable valve arrangement, was conducted into the hydraulic main; and it is in the place of these two coal retorts that the fixing chambers are to be set. The coke herein mentioned heated the coal as well as the oil retorts, but was all charged to the new apparatus.

To distinguish this method of making gas from others it was christened the "Standard Process." In effect, it is really a water gas process, with these differences from existing ones: 1st. The production of gas is constant, not intermittent. 2d. The same plant in all particulars now used for making coal gas can be employed with this process—adding only the generator and suitable valve and pipe arrangements; so that coal gas can be made one day and water gas the next, if so desired. For example, the plant necessary to make 150,000 cubic feet of gas in 24 hours would consist of a generator 3 ft. in diameter and not over 9 ft. (inside) high; one ordinary bench of coal retorts, with hydraulic main, etc.; one exhauster, and the usual scrubber, purifiers, and meter. 3d. Any kind of coal suitable for gas making can be used, and so can any kind of oil—it need not be naphtha.

Although no analysis of the gas produced has yet been made, the fact that it produced the illuminating power stated, with the labor and material given, would seem to encourage further trials. The process here described is still young, and perhaps capable of great improvement. It is quite simple, when you know how; but please remember—whatever be the theories—the results given are not theories, but facts that can be substantiated by the writer.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

Mr. Fish, of the Utica (N. Y.) Gas Light Company, on the Subject of Electric Lighting.—At the last annual meeting of the New England Association of Gas Engineers the first question* drawn from the question-box bore the title, "What advances have been made in electric lighting during the past year?" and in the discussion that ensued in the attempt to throw light upon the moot-point Mr. H. H. Fish, of the Utica Gas Light Company (who, it was pretty well known, had been concerned in some experiments of a practical nature well adapted to illustrate the debate), gave the details of what had been done by that Company in the direction of arc street lighting. We do not here propose to say anything further in respect to that discussion, since a reference to the specified pages of the Journal will explain exactly what was said at the time in regard thereto; and in fact the present mention of same is merely intended to show that the following letter, recently received by us from Mr. Fish, is especially noteworthy and valuable, as it sums up the careful, conscientious opinions of one who, from practical experience, is competent to sit in judgment on the "relative merits of electricity, gas and naphtha for street lighting purposes." Mr. Fish's communication is herewith appended:

Office of the Utica Gas Light Co.,
Utica, N. Y., Sept. 28, 1885.

To the Editor American Gas Light Journal:—Some few years ago experiments were commenced here in arc electric lighting which culminated in the construction of a tolerably well-equipped plant, constructed by the Central New York Electric Light and Power Company, the same including about 50 street lamps operated and maintained under the plan known as the Thomson-Houston system. This has now afforded about three years' practical experience from which could be deduced a fair judgment regarding the relative merits of electricity, gas and naphtha for street lighting purposes.

When electric arc lamps were first introduced as a medium for street illumination in our city of Utica they were received with every evidence of popular favor, notwithstanding their excess of cost over other methods. It was a new thing, and certainly gave to the streets so lighted a brilliant and even attractive appearance; but when the practical purposes of street lighting are considered—viz., *greater security* for persons and property—a more careful analysis of competing or opposing systems becomes necessary.

It may be fairly conceded that streets lighted by the aid of the arc systems of electricity present to the casual observer a more attractive appearance than those illuminated by other and older methods; but it is equally fair to say that the quality of the light, and its imperfect diffusion, when working under any of the systems yet developed, are far from satisfactory to those who pay the bills and are *personally* interested in the equivalent they have a right to expect and receive for their money.

The excessive cost of electricity makes it necessary to place the street lamps at greater distances apart than is required in the locating of gas or naphtha lanterns, so that any given territory lighted by an arc electric method may, for convenience, be divided into three very unequal parts—and of which much the smallest presents any satisfactory feature. For example, speaking of the first division—for the distance of a square or more from the usual arc lamp there is a painfully dazzling excess of light; in the second division—at the distance of a square or so the light is agreeable, although subject to a more or less irritating oscillation incident to irregular feeding of the carbons; and thirdly—this narrow belt of comparatively agreeable light rapidly lapses into ghastly shadows, with only sufficient illuminating effect to barely "make darkness visible" until approach or arrival is made to the next lamp in the circuit, where the dazzling excess of light (first noticed) is again experienced.

The intrinsic objections to the arc electric lighting method, as at present developed, and as compared with gas, would therefore seem to be: First, its excessive cost; second, the unequal and imperfect diffusion of the light at the very points where it is most needed.

Electricity does well enough in the lighting of large spaces, or in the illumination of such thoroughfares in our cities as are mainly devoted to the transaction of business, or to the purposes or objects of a public promenade—but even then always keeping in view the point that it can only be there successful when its excess of cost over gas is a matter of secondary consideration. Its use or employment under such circumstances, however, is found to increase the demand for more light; and look at it from what point you will, is thus shown to be a useful ally to and aid in the extension and growth of legitimate gas interests. Very respectfully, H. H. Fish.

Up to Their Eyes in Business.—Messrs. Connelly & Co., of Pittsburgh, Pa., report that business with them is in a most flourishing condition, and back up their statement by forwarding to us a list of their shipments during

*See Journal, issue of April 16, 1885, pp. 200-1.

the month of September. From this list we note that they filled 20 orders calling for iron sponge deliveries at points between Massachusetts and California! One lot of 90 tons actually going to Santa Rosa in the last named State. The largest single shipment (5,000 bushels) was sent to the works of Chicago Gas Light and Coke Company, and the smallest lot (50 bushels) was absorbed by the Eufala (Ala.) Gas Company. We note the following purchasers of sponge mixture as taken from the schedule: Consolidated (New York City), 300 bush.; Milwaukee (Wis.), 1,000 bush.; Louisville (Ky.), 4,000 bush.; Citizens (Newark, N. J.), 1,000 bush.; St. Joe (Mo.), 800 bush.; and so on to the end. The 20 orders foot up a grand total of sponge shipments, during the month in question, of 14,900 bushels. The purifying materials branch of their business, however, is not alone in possession of healthy activity, as the delivery of "automatic governors" for September included shipments of no less than 15 of these useful instruments. Of the 15 we note that four were 16-inch; two were 12-inch; four were 8-inch, and five were 6-inch. They also sent out from their factories four 6-inch gas exhausters in same month. That the "good work is liable to go on" may be inferred from the statement that, at time of receiving our information in regard to their doings, before end of first week in current month their orders included two 20-inch automatic governors for Consolidated Company, Baltimore, Md.; one 20-inch instrument for Syracuse (N. Y.) Gas Company; one 8-inch for Tiffin (Ohio) Company; and 6-inch governors for Bellefontaine (Ohio) and Pottstown (Pa.) Companies. The above rather goes to prove that the gas interests of the country are in a prosperous condition, and it moreover furnishes pleasing testimony about the excellence of Messrs. Connelly & Co.'s goods, besides redounding to the credit of the JOURNAL in its capacity as an advertising medium.

COKE FUEL AND THE JARVIS FURNACE.—In our last issue we published a report giving details of certain comparative evaporation tests made at the Silver Lake Company's mill, Newtonville, Mass., by the Jarvis Engineering Company, of Boston. In report of same we invited Mr. Upton to supply us with details of other and similar tests, and that gentleman kindly forwarded us data; but unfortunately the tests were made at a rather remote period, and consequently did not cover the desired points. In his note to us (for which we desire to extend our thanks) Mr. Upton makes the following interesting remarks: "We have had two applications from gas companies that are desirous of putting in plants for running electric lights in connection with their ordinary business. We have decided to ask our customer—the Silver Lake mill, where we made the tests published in your last—to allow us to make a test of a day's run in the use of coke as fuel. Many of our customers use this fuel right along under boilers set with the Jarvis furnace, and claim it is cheaper than any other material they can substitute for it. We wet the coke thoroughly, and where hot air is supplied above the fuel it seems to produce as good a gas flame as it would have done before (as coal) it was carbonized in the retorts." By all means let the tests be made, and the JOURNAL will be ready to publish the results of same. Mr. Upton's query in regard to the existence of a directory of gas companies is answered with the statement that the list compiled by the Goodwin Gas Stove and Meter Company, of Philadelphia, Pa., and bearing date of 1882, is out of print. It is quite likely, though, that a new edition will soon make its appearance.

RESOLVED TO INCREASE ITS CAPITAL STOCK.—Some time ago we had occasion to state that the Union Gas Light Company of East New York, L. I., proposed to increase its capital stock by the sum of $150,000. On Wednesday, Oct. 7th, the advertised stockholders' meeting for the purpose of accepting or rejecting the scheme was held, and an affirmative result was reached. The decision was practically unanimous, and the corporation will hereafter rejoice in the possession of a capital burden of $250,000. It is asserted that the money will be spent in extensions to plant, etc.

NEW EXHAUSTER TO THE ORDER OF THE GAS TRUST.—The Philadelphia (Pa.) Gas Trust officials have purchased, from Messrs. Wilbraham Bros., of that city, one of the largest size of exhausters constructed by this firm. The instrument is to be operated at the Germantown station of the Philadelphia gas works.

THE PERILS OF ELECTRIC LIGHTING WIRES.—Not much notice has been taken of the circumstance that electric light wires, passing through a box in the engine room of the steamship Waesland, during a recent trip of that ocean carrier of human life and valuable merchandise, on her journey from Antwerp to New York, caused a slight fire, which was fortunately extinguished before serious consequences resulted. It goes without saying that too great caution and circumspection cannot be exercised in the matter of looking after electric lighting plant on shipboard. Negligence in such matters is reprehensible enough, certainly, when the apparatus is destined to supply the landsman's need; but it becomes criminal when manifested aboard ship.

ACQUIRING REAL ESTATE.—From the records of the New York City Register's Office we learn that the Equitable Company has recently acquired property (from Mr. Rutherford Stuyvesant) located on the north side of 58th street, and extending through to 59th street, at a point about 300 feet west of Tenth avenue. The consideration passing between the parties to the transaction is placed at $176,000.

THEY MADE A "PROPOSITION."—It is said the Rockford (Ills.) Electric Light Company has recently closed a contract with the Western Edison Electric Company, of Chicago, for 1,200 ten-candle power lamps. The capital stock of the company has been increased by $30,000, making a total of $50,000. Of course, they are after a portion or the whole of the public lighting, and have made a proposition to the officials there for the performance of the same. We do not know the particulars thereof, although we may venture the surmise that when it comes to the question of estimating the candle power to be given the city in the street lamps (with the understanding that the Edison incandescent system is the one proposed to be employed) those 10-candle power lamps recently purchased will be rated somewhere in the neighborhood of 16 candles. The local electricians do not appear to be on the same level with retail coal dealers in that the latter buy by the long and sell by the short ton, while the former "purchase by the short light and sell by the long one." However, though their purchases and sales are made on a varying basis, the ultimate result is identical—the final purchaser is always "sold." Perhaps the Rockford gas folks would let us know something about the proposition submitted.

A NEW GAS AND ELECTRIC LIGHT COMPANY.—A company has been organized at Orlando, Florida, for the purpose of constructing and operating a gas and electric lighting works in that town. Its capital stock is fixed at $50,000, and the incorporators of same are Messrs. W. R. Anno, N. L. Mills, N. Poyntz, T. J. Shine, and J. B. Paramore. Orlando is the capital of Orange county, Florida, and is about 90 miles south of Palatka. We wish the new venture all success, but fear that Orlando's population is hardly up to the mark of sustaining such an enterprise.

PERSONAL.—In our "item" columns for Sept. 16th we mentioned that the Evanston (Ills.) Electric Light Company's managers were exceedingly anxious to guide the wayfarer's footsteps over safe lines through being allowed a slice of the public lighting of that city; and we then invited Mr. T. A. Cosgrove "to throw some light on the subject." Brother Cosgrove was seemingly rather dilatory in forwarding a reply, but the reason thereof was made apparent in a right pleasant manner. He intended to make an extended visit East, and so considered it best to carry the news in person, consequently one morning not long since the genial gentleman made his appearance at "top of 4th flight in No. 42," and somehow or another was inclined to find fault with landlord Hoyt's elevator. Our visitor informed us it was quite unlikely the electrical promoters would get a foothold in Evanston until they agreed to bury their wires, and that probably ends the matter. Mr. Cosgrove will pay a visit to the "Novelties" Exhibition, and he will also be in attendance at the sessions of the Cincinnati gathering. Judging from his rotund and trim appearance we should say that the Evanston electricians have not caused him any decided uneasiness as yet.

WHAT FRIEND HARBISON IS DOING.—Jno. P. Harbison, of Hartford, like unto many of his brother gas men, has had a busy time of it this summer. The principal cause of his summer devotion to business arose from the carrying out of an extensive plan for increased distribution facilities. Long sections of 8 and 10-inch mains have been replaced with pipe 16 inches in diameter, and he now breathes easier, and so will the Hartford gas works next winter. During the progress of the work not a single consumer was deprived of his gas supply.

THE FURIOUS WORK OF A RECENT CYCLONE.—At the late Chicago meeting of the Western Gas Association Mr. G. A. Hyde, sr., read a paper,* on the subject of "Pressure of Gas in Street Mains," and in the discussion which followed the vagaries and eccentricities exhibited by a "real Western cyclone" were freely commented upon. Many of the gentlemen present were rather incredulous about the experiences related, and seemed inclined to view the matter as overstated. Now (and while the newspaper accounts of the September cyclone that almost demolished the town of Washington Court House, in Ohio, are still fresh in the memories of our readers) we are enabled to present some facts, in regard to these terrible visitors, that are perfectly reliable and for which we are indebted to Mr. Joe. M. McLean, Secretary of the Washington Gas Light Company. Mr. McLean's statement is as follows:

* See JOURNAL, Vol. XLIII., issue July 2d, 1885, pp. 3, 4, 5.

OFFICE OF WASHINGTON GAS LT. CO.,
WASHINGTON C. H., Sept. 26, 1885.

To the Editor AMERICAN GAS LIGHT JOURNAL:—In compliance with your request I will say the cyclone that struck our city on the evening of Sept. 8th dealt our town a heavy blow. It made its appearance at the hour, and from the usual direction, that cyclones take—in early evening and from the southwest—accompanied by heavy rainfall. It seemed to possess a gyrating motion, as many things blown down point in the direction from whence the wind came. Those who particularly noted the onward approach of the cloud describe it as having been intensely black, frequently illuminated by vivid streaks of lightning, running, not in the usual zigzag manner, but vertically from zenith to horizon. The section that caused the damage did not take up over one minute's time in passing a given point. On reaching the town the clouds parted, the currents being separated by a distance of about 300 feet. The one to southeast was the most destructive. Buildings located on corners of streets or alleys suffered greatest. The current, striking a building and demolishing it, would bound over to the next square, and leave the intervening structures almost, if not entirely, unharmed, while the second point of contact would present a spectacle of unroofing. The second contact was not nearly so powerful in its destroying qualities as was the first, or else our gas works would now be wanting. Three hundred feet from our works, right in the direction from whence the visitor was traveling, two dwelling houses were badly damaged; and, strange to say, it swept over the gas works proper, leaving the same undamaged, save the wiping out of a portion of the roof. Fifty lanterns and probably half as many posts were blown—we know not where. Our holder (it was filled to the water's edge) sank in the water—to what depth I cannot say, but so strong was the pressure upon it that, when relieved, it bounded back with sufficient force to wrench every wheel from the guide rails, and exhausted the lights from a considerable portion of the town. Fortunately the holder sustained no great injury. Twenty-seven feet from a two-story brick building runs a 2-inch cast iron main, buried at a depth of 30 inches. About 15 feet of side wall of this building was blown down directly over the main. Next morning the odor of gas was detected emanating from an areaway, say, 17 feet distant from point of fallen wall. We dug down to pipe and found it broken. The iron was in good state of preservation—the jar from falling wall must have ruptured it. A reference to the books of our relief committee shows that 25 houses were entirely destroyed; 100 more sustained damages amounting to from 10 to 75 per cent. of their value; 6 persons were killed, and 500 people required assistance. As an instance of the destruction wrought upon some households that of one of our stokers affords an unfortunate example. With a family of five children he occupied a four-roomed dwelling; the children were being prepared for bed, when the cyclone came and in one short moment they found themselves standing on the ground, *where the house had been*, in a drenching rain. Everything they possessed was either broken up or blown away, save the cook stove and the clothing on their persons—fortunate only in that they escaped unhurt. As it swept through our cemetery tall granite columns were thrown from their bases with as much apparent ease as it twisted into fragments the fragile limbs of the evergreen trees.

Respectfully, Joe. M. McLEAN.

THE TEST WAS MADE.—In an item given elsewhere the hint was advanced that the Jarvis Furnace Company would likely make a comparative evaporation test, using coal and coke as fuels. The tests have been made, and report of same will appear in our next.

Gas Stocks.

Quotations by Geo. W. Close, Broker and Dealer in Gas Stocks,

16 WALL ST., NEW YORK CITY.

OCTOBER 16.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share.

	Capital.	Par.	Bid	Asked
Consolidated	$35,430,000	100	95½	96¼
Central	440,000	50	60	70
" Scrip	220,000	—	47	57
Equitable	2,000,000	100	133	135
" Bonds	1,000,000	—	107	110
Harlem, Bonds	170,000	—	—	—
Metropolitan, Bonds	658,000	—	110	113
Mutual	3,500,000	100	132½	133
" Bonds	1,500,000	1000	104	107
Municipal, Bonds	750,000		—	—
Northern	125,000	50	50	—
" Scrip	108,000			
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	130½	132
Citizens	1,200,000	20	84	86
" S. F. Bonds	320,000	1000	106	110
Fulton Municipal	3,000,000	100	159	160
" Bonds	300,000		104	108
Peoples	1,000,000	10	84	86
" Bonds	290,000	—	105	110
" "	250,000	—	90	95
Metropolitan	1,000,000	100	91	93
Nassau	1,000,000	25	126	—
" Ctfs	700,000	1000	98	99
Williamsburgh	1,000,000	50	162	164
" Bonds	1,000,000	—	111	114
Richmond Co., S. I.	300,000	50	64	75
" Bonds	40,000	—	—	—
Out of Town Gas Companies.				
Buffalo Mutual, N. Y.	750,000	100	80	85
" Bonds	200,000	1000	95	100
Citizens, Newark	918,000	50	103	115
" " Bonds.	124,000	—	105	110
Chicago Gas Co., Ills	5,000,0000	25	130	140
Peoples G. L. & C. Co., Chicago, Ills			8	12
Cincinnati G. & C. Co.			180	182
Consolidated, Balt.	6,000,000	100	47	48
" Bonds	3,600,000		107	107½
Central, S. F., Cal.			—	58
Capital, Sacramento, Cal.			56	—
Hartford, Conn	750,000	25	123	129
Jersey City	750,000	20	140	150

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Second-Hand Gas Apparatus.

One Condenser, 4½ ft. diameter by 13 ft. in length over all, containing 150 two and one-half inch tubes, 8 ft. long with 12-in. connections and bye-pass.

Two Smith & Sayre (12-inch) Steam-Jet Exhausters, with **3 Self-acting Bye-Passes.**

Four Purifying Boxes, 10 ft. by 14 ft. by 3 ft., with 12-inch connections and center seal.

All in good order, and will be sold cheap. Address

PETER P. MILLER, Manager Citizens Gas Co.,
Buffalo, N. Y.

TENDERS
FOR
Lighting the Streets of Toronto.

Tenders, addressed to the undersigned, will be received by registered post up to 12 o'clock noon of

Tuesday, the 1st December, 1885,

for the lighting of the streets of the City of Toronto, Canada, with Electric Light, Gas Light, or other illuminant, for one, three, or five years from the 1st day of July, 1886, or sooner if practicable.

Specifications can be seen and a copy of the same obtained on application at the office of the Chief Engineer of the Fire Department, corner Bay and Temperance streets, or at the office of the City Clerk, City Hall, after the 15th day of October.

A cash deposit, or marked check made payable to the order of the City Treasurer, for the sum of one thousand dollars, must accompany each and every tender, together with the *bona fide* signatures of two responsible persons who will become sureties for the due fulfillment of the contract. The deposit accompanying the tender will be forfeited to the city in the event of the person or persons whose tender is accepted failing to execute the necessary contract or give satisfactory sureties for the due fulfillment of the same. Deposits of unsuccessful tenderers will be returned.

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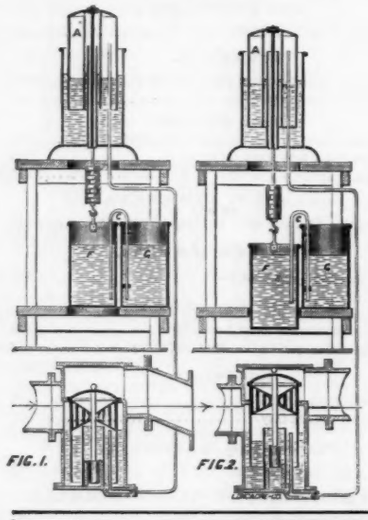

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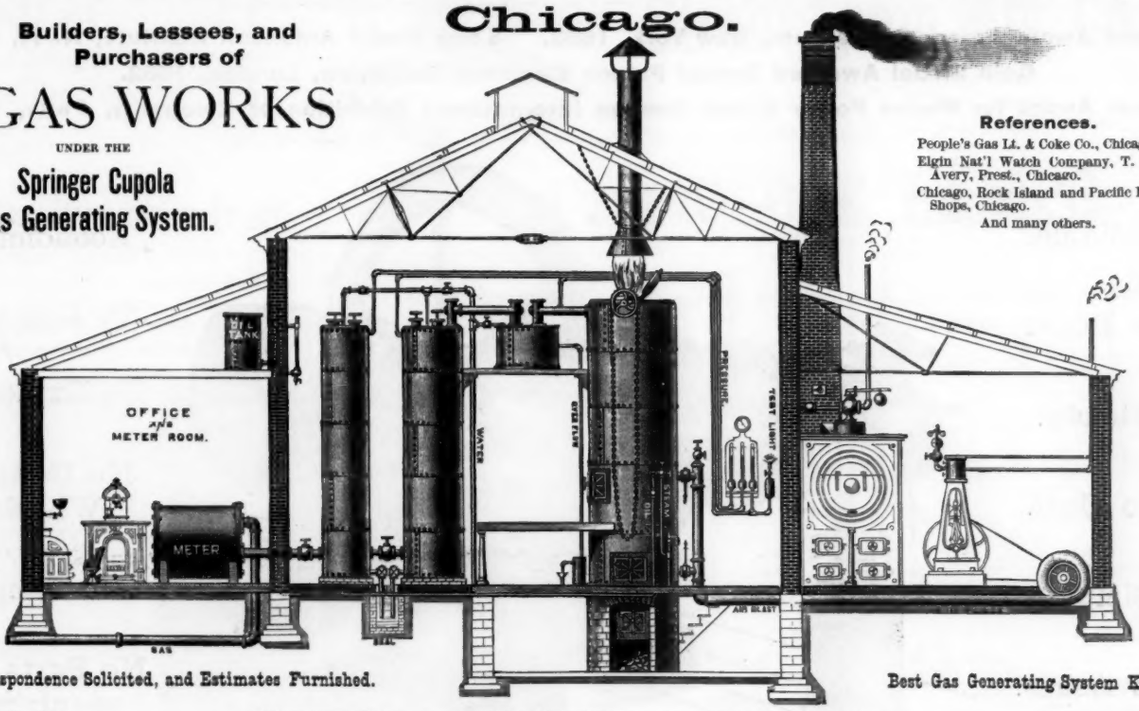

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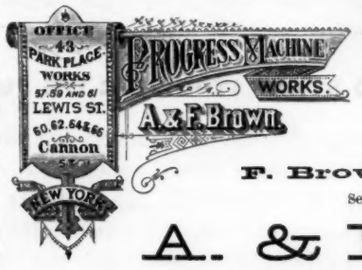

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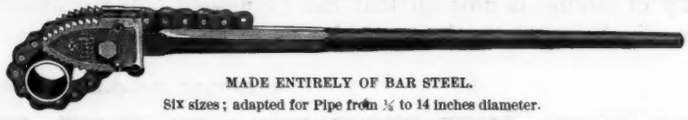

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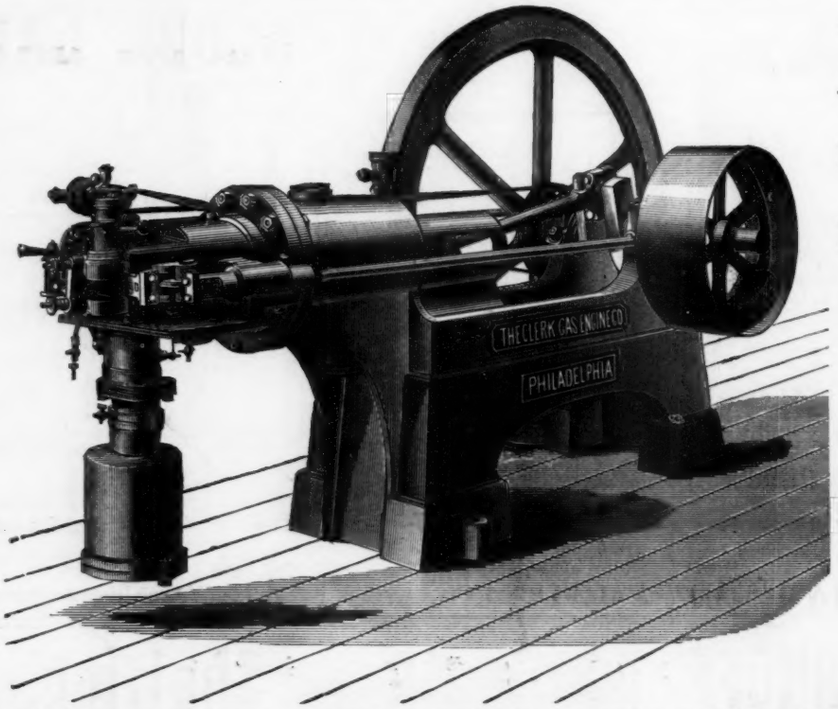

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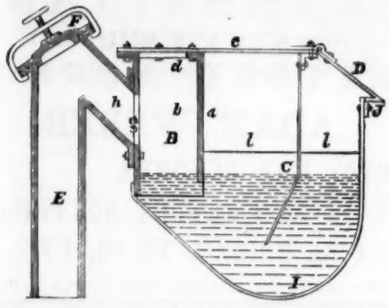

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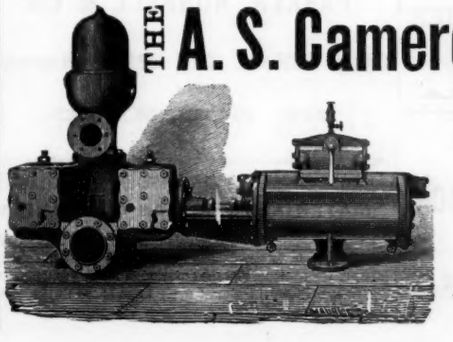

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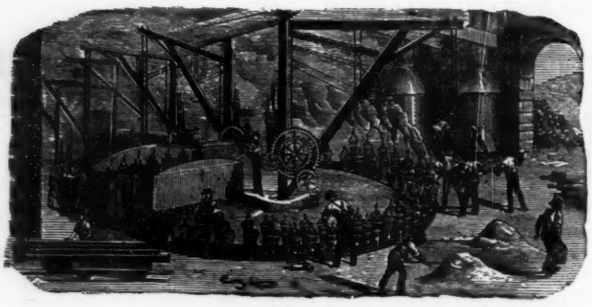

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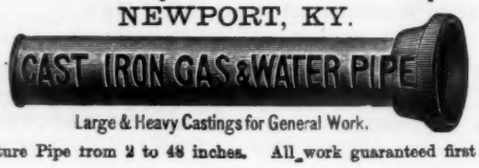

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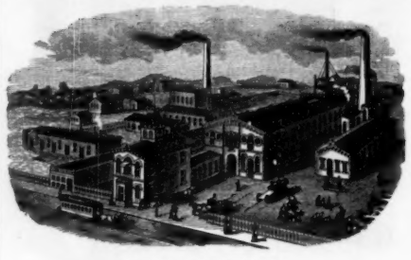

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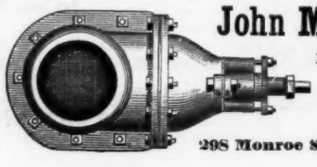

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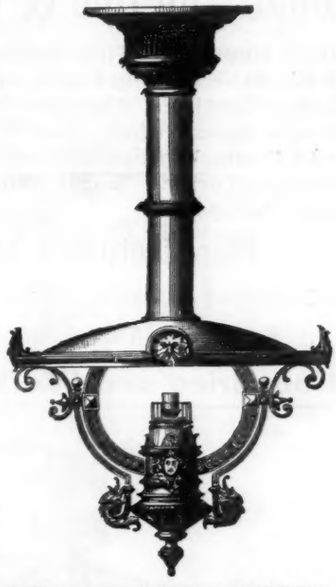

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1880	42,967,500	"
1881	36,462,500	"
1882	39,300,000	"
1883	57,735,000	"
1884	26,177,500	"
Total	235,937,500	cubic feet.

Total Number and Capacity per 24 Hours of "Standard" Washers Erected and in Course of Erection in the Several Countries

	Number.	Cubic Feet per Day.
Great Britain	151	157,070,000
Western Hemisphere	38	39,337,500
Australia	18	12,150,000
New Zealand	2	650,000
France	6	4,550,000
Belgium	8	5,420,000
Germany	16	8,200,000
Holland	4	4,160,000
Denmark	1	150,000
Russia	2	3,500,000
Spain	1	350,000
India	1	400,000
Total	348	235,937,500

THE CONTINUED POPULARITY
Of these Machines

Will be recognized from the following extracts from letters from representatives of some of the companies having them in use:

PROVIDENCE GAS COMPANY,
PROVIDENCE, R. I., Nov. 24, 1884.

GEO. SHEPARD PAGE, Esq., New York:

Dear Sir—We are now using less than a gallon of water per thousand in the "Standard," and the gas at the outlet will not color turmeric paper.

Yours. etc.,
A. B. SLATER, Treasurer.

PORTLAND GAS COMPANY.
PORTLAND, ORE., Nov. 29, 1884.

GEO. SHEPERD PAGE, New York:

Dear Sir—Our Scrubber appears to run to our entire satisfaction, and we are pleased to say that it takes out all the ammonia from the gas. This is *very* satisfactory to us, as we were ruining our meters at a fearful rate heretofore. The amount of water used is very inconsiderable as compared with our old process. The machine runs very smooth and still. Very respectfully,

H. C. LEONARD, Secretary.

"Standard" Washers Ordered Recently.

	Cu. Ft. per Day
Anneberg Gas Co	200,000
Bombay Gas Co	400,000
Brussels Co	1,250,000
CHICAGO, two, 1,000,000 each	2,000,000
Chemnitz Gas Co	1,000,000
CITIZENS GAS CO., BUFFALO	750,000
Coke Works in Zabre, Ober-Schlesien	1,500,00
Cokerei der Friedenshutte, Upper Silesia	500,000
Dumfries Corporation	250,000
Dunedin Gas Co., New Zealand	400,000
GEORGETOWN, D. C	250,000
King's Lynn Gas Co	300,000
Leiden, Holland	600,000
Lincoln Gas Co	400,000
Liverpool Gas Co	2,000,000
" "	3,000,000
LOUISVILLE GAS CO	1,500,000
Numea Gas Co	100,000
PITTSBURGH GAS CO	1,500,000
PAWTUCKET, R. I	500,000
PORTLAND GAS CO., Oregon	562,500
SAN FRANCISCO GAS CO	4,000,000
Sheepbridge	40,000
ST. LOUIS GAS CO	2,000,000
Sydney Gas Co	2,500,000
WASHINGTON, D. C. GAS CO	2,000,000
Whitchurch Gas Co	175,000
Total	29,677,500

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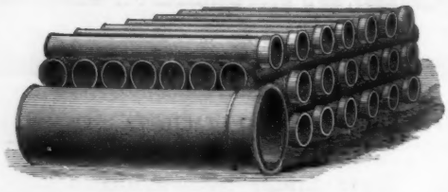

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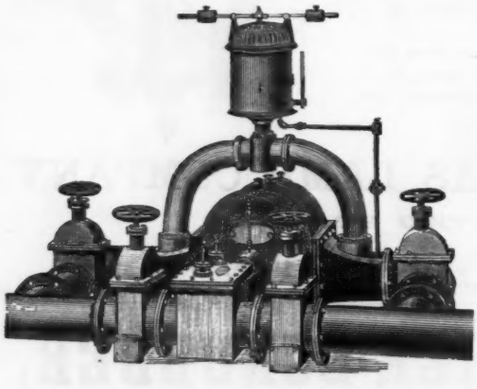

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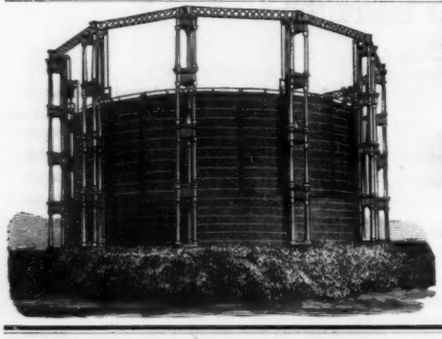

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Akron, "	"	80,000 "
Xenia, "	"	10,000 "
Adrian, Mich	"	65,000 "
Ypsilanti, Mich	"	25,000 "
Muskegon, "	"	70,000 "
South Bend, Ind	"	70,000 "
Anderson, "	"	20,000 "
Plainfield, "	"	10,000 "
Springfield, Illinois	"	100,000 "
Evanston, "	"	50,000 "
Freeport, "	"	35,000 "
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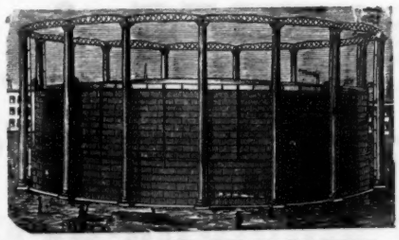

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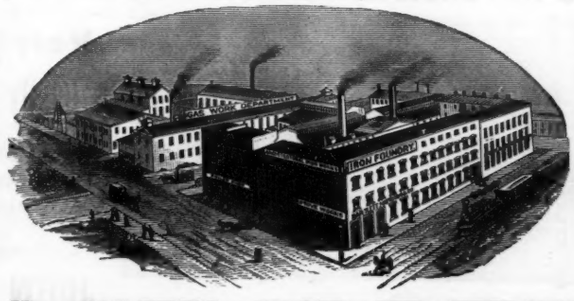

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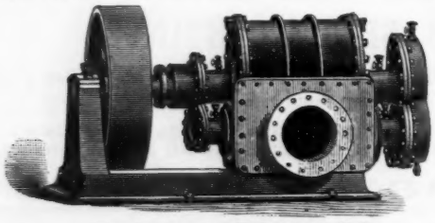

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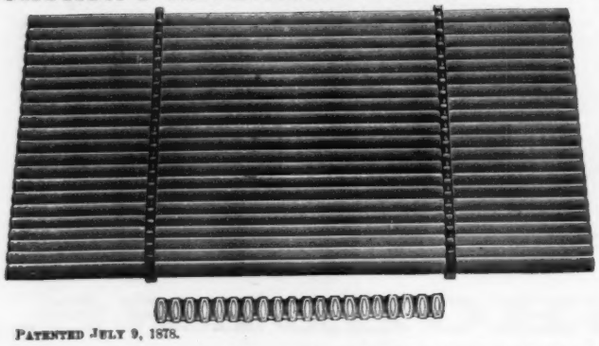

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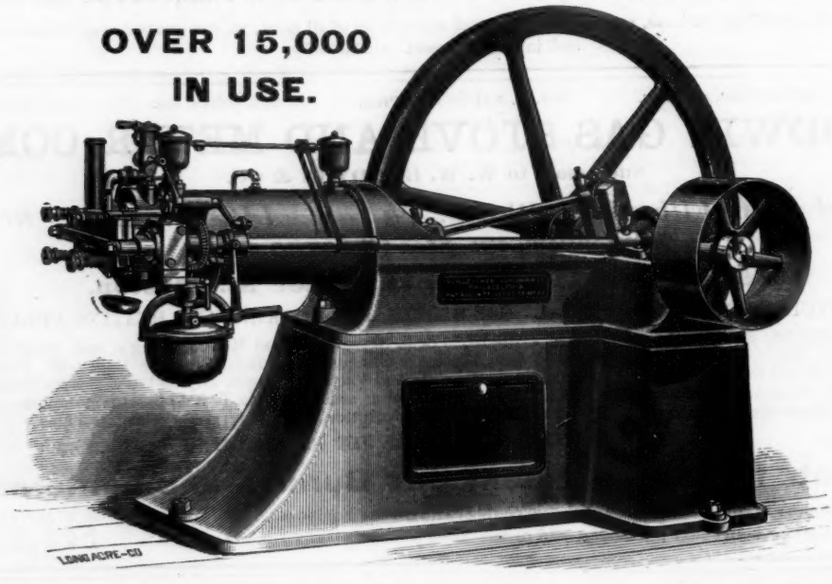

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